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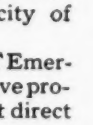

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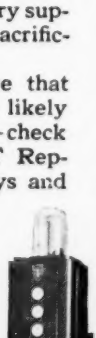

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Wartime Problems of Supply, Operation and Design

By Louis R. Howson

THERE never has been a time when resourcefulness, ingenuity and the ability to do more with less have produced greater dividends than at present. Time and energy spent in learning how to adjust present facilities for greater service or how best to use substitute materials are a direct contribution to the war effort.

Emergencies are usually productive of new ideas. When old methods and materials are not available it becomes necessary to make a critical survey of the various practicable means of accomplishing a desired result. Such a survey is quite likely to create advanced procedures, largely as a matter of necessity. Some of the present developments, born of such necessity, will doubtless become standard practice in the postwar period.

The responsibility for maintaining continuity of adequate water service is a heavy one. There are literally hundreds of important water supplies in the United States which have never been shut down for a single minute in half a century. To maintain that record and protect both the health and property of the community under the prevailing conditions of shortages of critical materials is, to say the least, difficult.

The first job of every water works man as well as of every other citizen is to help win the war. His most important contribution is made through being absolutely sure that his system can meet the necessary requirements for water service, both for general use and for the protection of the community against fire—itself a saboteur. He must provide this assurance with an absolute minimum of materials otherwise needed for the war effort.

No water works man should ask for critical materials until it is positively demonstrated that the necessity for their use exists and that the requirements cannot be met by any other method requiring a lesser use. However, the converse is equally true. A

A paper presented on April 8, 1943, at the Illinois Section Meeting, Springfield, Ill., by Louis R. Howson, Alvord, Burdick & Howson, Engrs., Chicago.

water works man would be derelict in his duty if he did not properly present his application to the War Production Board after having made a careful survey which clearly showed that a necessity exists and can only be met by the use of the specified minimum of critical materials for which he is asking.

One way to conserve critical materials is through the continued maintenance of even old equipment in good operating condition. Such equipment, while frequently uneconomical, is usually reliable. The increased cost of operation is a small price to pay for the diversion of the additional critical materials to the war effort.

Similarly, where there is a deficiency in feeder main capacity in an old system, a material increase can frequently be secured by main cleaning. In the average midwest system, cleaning of a 16-in. main, e.g., one that has been in service for 35–40 years, will provide additional carrying capacity equivalent to that which would be supplied by a new 12-in. main; and cleaning a 12-in. main under the same conditions will provide additional capacity equivalent to that which would be furnished through a new 8-in. main.* Additional capacity secured by cleaning mains requires practically no use of critical materials.

Main extensions can sometimes be deferred by locating and curtailing water waste. If the pumpage is reduced by but 10 per cent (an amount not unusual to find wasting from a single large main leak), the pressure loss to that area will decrease approximately 20 per cent. In Chicago only 30 per cent of the water services are now metered. The adoption of universal metering would have made it possible to double the pressure in the low-pressure areas of the city on days of heavy consumption. A waste survey and elimination of waste which it discloses will frequently postpone main construction otherwise necessary. This alternative should not be overlooked in this war period.

Supply Problems

Cross-connection of the municipal supply with other supplies has long been frowned upon by health authorities and even a war emergency cannot release the water works from its highest obligation—that of furnishing a 100-per cent safe supply. In these critical days, however, every water works executive should have complete knowledge relative to the other supplies developed within the area served by his distribution system. He should know the extent of each development, should have sufficient analyses of the water each furnishes to ascertain its availability for domestic use and should make a study of the materials necessary to cross-connect that system with the municipal water works in case of emergency. In the most critical areas the facilities for making the cross-connections, including facilities for sterilization, should be held in readiness, for use if necessary. Water is an essential material in practically all war work.

The war effort, either alone or in conjunction with industrial developments, has created acute water shortages in a great many communities, including a number in Illinois. Most war industries, such as those manufacturing industrial alcohol, explosives, magnesium castings and airplane motors, require large quantities of comparatively

* Howson, Louis R. Repairing for Defense. Jour. A.W.W.A., **34**: 793 (1942).

cool water, which can best be supplied from underground sources where available. Developments of this type have created acute conditions in Illinois in the East St. Louis-Alton industrial area, the Peoria industrial area and in the region adjacent to the Kankakee Ordnance Works. These situations were sufficiently acute to result in the appropriation of $100,000 by the State Legislature to finance research work, which is now in progress, by the Illinois State Water Survey.

As a means of increasing the amount of water that can be drawn from shallow well supplies, flooding of areas adjacent to the wells has been resorted to in a number of places. Des Moines, Iowa, where flooding has been practiced in connection with the infiltration gallery supply is one of the long time illustrations of the success of this type of underground supply replenishment.* In dry years as much as 35 per cent of the total use has been secured from water pumped to flooding pools and filtering through the soil to the galleries. Other large developments are in operation on the west coast. At Dayton and Springfield, Ohio, replenishment of underground supplies by flooding is also extensively practiced.

Flooding, where used, should be laid out with respect to the porosity of the strata between the flooded areas and the wells—the more porous the material the greater should be the length of travel. In general, the rate of recharge may vary from 200,000 gpd. per acre to as much as 2 mgd. per acre, the latter being in very coarse materials. Where a turbid water is used for flooding, as is frequently the case where river waters are used, there is a tendency for the ground surface to clog. This deposition, which retards flow and increases the efficiency of natural filtration, is usually removed periodically by bulldozer scraping or similar procedure during periods of low use and high underground yield.

The Illinois State Water Survey has conducted a series of experiments to determine the applicability of land flooding to recharging in the Peoria industrial district. An engineering report on the practicability of recharging has also been made. The system suggested for Peoria involves the recharge of the gravel beds with cold water from the Illinois River during the cold weather period. The water would be withdrawn from the gravel at a more or less uniform rate throughout the year. Because of the high pollution load of the Illinois River and the availability and location of the recharge areas, it was recommended that close observation be exercised over the bacterial quality of the water and that the water should not be used for sanitary purposes.

The war has resulted in varying conditions of water system growth. The use of water in and adjacent to war industry or camp areas has expanded very greatly, but in other areas the demand has decreased proportionally. Recent annual reports of two of the larger water works holding companies show that, as an average on their systems supplying several million people, the total number of consumers had declined over 1 per cent during 1942. That is, of course, a reflection of the inability to take on new consumers as well as the actual transfer of old consumers to areas in which war work was being done.

* Burdick, Charles B. Ground Water—A Vital National Resource—Midwest Problems. Jour. A.W.W.A., **34**: 1610 (1942).

Design Problems

The war has also exerted its influence on design practice. Substantially all water works construction in the last year or two has been directly for the war requirements.

As previously mentioned, one of the requirements of water supply, for many of the more important war uses, has been that of uniform and low temperature. This has resulted in the development of many very large well water supplies and the adoption of new or modification of old methods of well construction.

The ability to draw large quantities from small areas of very coarse materials, usually immediately adjacent to rivers and with the gravel subject to rapid recharge from the river, has led to a number of installations of "Ranney" wells. These consist of a concrete shaft extending down into the porous gravels through the shell of which extend radiating steel pipes and strainers extending out as far as 100 ft. or more from the main well. Pumping is usually done by motor-driven deep-well turbine type pumps. Unit developments as large as 10 mgd. have been made. Where the recharge from the river contributes a large part of the yield, the temperature varies proportionately between those of the underground and surface supplies. This type of construction is limited in its economical application.

In other locations in an effort to conserve the critical materials required for casings and strainers, use of concrete pipe and strainers for the well tube has been adopted. An illustration of this is the Mill Creek development for the Wright Aeronautical Corp. at Lockland, Ohio, where eleven gravel-packed wells, 17 in. in diameter and 150–240 ft. deep, are now being drilled. Wells of this type have been in use in Pekin and Peoria, Ill., for several years.

Reservoirs, construction of which has been fairly well standardized for years in the reinforced concrete flat slab type, are now, in most cases, being designed with sloping sides built in balanced excavation and fill, the embankment being rolled according to the best type of dam construction and provided with a plain reinforced concrete lining and a wood roof. Comparative studies of a recent 22-mil.gal. reservoir showed that this type of construction would save over 1000 tons of critical materials over the box type. If, at a later date, a reinforced concrete roof is desired it can be installed at a cost, including the present wood roof, of only 20 per cent above the initial cost of the box type construction. In the meantime, the wood roof will have furnished fifteen to twenty years of satisfactory service.

The war itself has resulted in a great amount of water works construction. The War Department Office of Technical Information has issued the following summary information on construction work at War Department stations *:

Mains up to 30 in. in diam., *mi.*	6608
Service pipe, *mi.*	2680
Total capac. of filter plants, *mgd.*	191
Min. water use at all stations, *mgd.*	500

This report points out that "the mileage of water mains is greater than that of New York City and the water consumption is well over half that of New York City." Another way of emphasizing the vast amount of this type of construction is to point out that

* Water Supply Engineering. Rpt. of Com. of San. Eng. Div. for the Three Years Ending Dec. 31, 1942. Proc. A.S.C.E., **69**: 406 (1943).

it is sufficient to supply roughly 5 per cent of the total population of the United States now having access to municipal water supplies.

The requirements of such a construction program in so short a time, combined with the extreme urgency of conserving critical materials, have very greatly expanded the use of asbestos-cement and concrete pipe. This expansion so taxed the facilities of the manufacturers of those materials that delivery could not be secured for many months after placing of the order. Because of this, some orders for asbestos-cement pipe were later cancelled and cast-iron pipe specified. At the present time the principal pipe foundries have much of their capacity idle due to the slowing up of purely war construction and the lack of civilian orders. The use of reinforced concrete for pipe of large sizes to be used under moderate heads effects important savings in critical materials. On the Mill Creek project, for instance, 36-in. centrifugal reinforced concrete pipe for a 100-ft. head required only 36 lb. of reinforcing steel per linear foot. The weight of this steel was about one-third that of the thinnest steel shell pipe that it would have been practicable to use ($\frac{1}{4}$ in. thickness) and about 10 per cent of the weight of Class A cast-iron pipe. The saving in critical materials is apparent. This $3,000,000 job with twenty miles of large pipe, a 15-mil.gal. reservoir and eleven gravel-packed wells required only 1500 tons of critical materials.

Operation Problems

One of the things that the emphasis on civilian defense has pointed out is the necessity of keeping the maps of the distribution system and all piping connections thoroughly up to date. The location of valves, particularly those affecting important mains, should be well indexed and the pertinent information should be in the hands of those responsible in case of a break.

It should not be necessary to point out again that this is a time when water waste should be curtailed to the absolute minimum. In passing, it should be stated that much has been accomplished along this line in recent years. Whereas fifteen years ago an extensive survey of unaccounted-for water in fully metered systems showed that the average completely metered city was accounting for approximately 75 per cent of the water pumped, today that figure has been raised to approximately 85 per cent. In many cities, where particular emphasis has been placed upon meter repairs and detection and repair of leaks in the mains and services, the percentage accounted for now approximates 90 per cent.

The present period, when no new construction can be undertaken, is a good time to bring the meter testing program up to date. Increasing the efficiency of meters is, however, largely a revenue rather than a waste prevention matter.

Water systems that are supplying war industries or, particularly, military camps, are experiencing new problems of supply during peak hours. The rates of use in camps fluctuate over a much wider range than do those of civilian uses, due to the "simultaneous" habits of the trainees. In this connection it is interesting to note that at Des Moines, where one of the largest concentrations of WAAC's is located, water requirements seem to differ somewhat from those at men's camps. The peak use for women in service comes after drills in the afternoon, said to be partly due to the amount of

water that is used for washing stockings and underwear during those hours. Peak uses of this type can frequently best be met by surface storage, of a type using little critical materials, and an automatic electric booster pump.

Manpower is a critical material. When the military calls men from employment, most water works are attempting to fill the positions with women if that is possible. One, at least, of the large water departments has furnished employment to the wives of many employees called to service, with the idea that the complications resulting at the time of the man's return will, thus, be less than otherwise.

One means of conserving manpower adopted by many water works has been that of skipping two out of three of the regular monthly meter readings for residential services. Several of the state public utility commissions have approved this procedure. The customer is sent his average bill for two months and the third month based on the actual reading adjusts any irregularity resulting from the skip reading practice. Bills are rendered monthly as usual.

The war has complicated the financial problems of many municipal water works. Ordinarily a municipal water works is a growing institution, from 10 to 25 per cent of the revenues of which have normally been expended for new construction. Due to the fact that the war has curtailed new construction, the water works surplus above operating requirements is currently greater than normal, a fact which has, in many cases, led to its diversion from the water works surplus to other city channels. In general this is not a wise procedure. The requirements for the expenditures for new construction are usually accumulating and the only practicable method of meeting them is to have funds available when the emergency is over.

Every water works should have a program of construction required by the forecast requirements of ten to twenty years in the future. The funds required for that expansion should remain in the possession of the water department, available for use when needed and when the materials are made available. A carefully developed construction program is usually the best antidote for diversion of water works funds. Idle surplus not earmarked for specific construction is a temptation to the ordinary city official.

Another effect of the war upon operations has been to place a greater dependence upon sterilization. In many cases due to the greater water requirements and the inability to secure construction materials, rates of filtration have necessarily been stepped up. In most cases this can be safely accomplished by the use of somewhat more than normal amounts of coagulant and chlorine. Although not recommended as an ordinary operating procedure, this practice has merit in making available for the war effort critical materials which would otherwise be required for additional filter construction.

Canadian Planning for Postwar Reconstruction

By W. C. Miller

THE term "postwar reconstruction" is one that is being heard more and more frequently during these times. Most of those who use it, however, have no very clear idea of what is involved, primarily because of the difficulty of interpreting it simultaneously in terms of the general problem and the specific application.

The James' Committee on Reconstruction appointed by the Dominion Government has been at work for almost two years. The results of some of its work, that of its several subcommittees and of it staff are just coming to light. First drafts of its "Considerations for Evaluating Postwar Construction Projects" [an outline of the reported form of which is published herewith, p. 554] have been circulated among Canadian water works men, but no general publication of the committee's studies has been attempted. There is probably some very good reason for the general lack of publicity that has attended the committee's work, but this has had the effect of encouraging the creation of many and varied local and general committees to study postwar problems. Such small groups, working without knowledge of the groundwork already laid, might have been engaged in more constructive investigation if they were able to take advantage of what had already been done and to make their own studies fit into the general pattern that has been the basis for the main committee's work.

This framework or pattern with its basic assumptions and principles may be compared with the strategy of a military campaign. It may appear for the present to be the best and most logical approach to the problem, but it is subject to change from time to time if and when the situation does not develop in accordance with the original assumptions. There may even be other strategies that are just as good. If everyone were to develop his own, without reference to others, however the result would be chaos, similar to what would happen if every general worked out his own basic strategy in a campaign and based his tactics on that, rather than on what had been adopted by the general staff. Thus it appears that it will be of value to examine the official study pattern—the over-all strategy.

Once there develops a clear picture of what postwar reconstruction involves, individual studies should be approached with an open mind. Reliance should not be placed on old theories and practices unless, in the light

A paper presented on April 7, 1943, at the Canadian Section Meeting, Hamilton, Ont., by W. C. Miller, City Engr., St. Thomas, Ont.

of critical examination, they prove themselves worthy of perpetuation. No doubt a great many are. In approaching this study, however, it will be well to keep in mind, as a guide, the first principle laid down by Sir William Beveridge in his celebrated report on "Social Insurance and Allied Services":

"The first principle is that any proposals for the future, while they should use to the full the experience gathered in the past, should not be restricted by consideration of sectional interests established in obtaining that experience. Now, when the war is abolishing landmarks of every kind, is the opportunity for using experience in a clear field. A revolutionary moment in the world's history is a time for revolutions, not for patching."

Dr. James has said somewhat the same thing: "Reconstruction compatible with full employment being provided will be, as far as possible, a continuing aspect of our present policy of basic Canadian political and economic traditions. What has happened in the past and what is now happening will have its effect on what we do in the future."

Types of Projects

The James Committee has studied the events that followed the last war and has determined the reasons for them. This information was applied to the present situation and indicates the likelihood of a boom following this war. It will not, it is believed, be as intense as the postwar boom of the Twenties. There is even a possibility that it will be so small as to appear nonexistent. If it does occur, it will provide a breathing spell when the rehabilitation of industry might be accelerated. A postwar depression that will undoubtedly follow the boom period will make itself apparent in local unemployment where industry has not been able to make the necessary adjustments satisfactorily. At this point governments will have to take their traditional place as the means whereby the slack in private industrial employment is taken up. It will therefore be necessary to have in reserve a program of publicly financed construction projects. To most people this is the whole program. In reality, however, it is only an incident in the reconstruction program, a necessary incident it is admitted, but only a small part of the whole, a sort of economic aspirin tablet to relieve a local discomfort. The whole problem must be attacked while the local effect is being alleviated.

It is at this point where the palliative can be used with a double purpose. Relief projects of unhappy memory should not have any place in any works program. Men engaged on these works must be satisfied that they are engaged on a necessary project that has a definite and permanent social value. Work of any other kind would encourage that malicious practice so aptly termed "boondoggling" in the days of the great depression. It is in this respect that the water works man must use his best efforts. There are many opportunities in a water works plant for effective and useful plant expansion. In addition there are many projects that do not involve physical extensions, but which will provide employment and an economically useful service. It behooves the water works engineer to plan in advance for this emergency. That public money will have to be expended at such a time is self evident. It is of vital importance that it be spent wisely.

The experience of the early Thirties should be sufficient to indicate that the system of using hand labor, when machines are available that will do the work for a fraction of the cost, should be banished forever. When possible, the established construction organizations should, without too many restrictions, be permitted to offer their services competitively as in normal times. Normal rules of employment should be adhered to, consistent with the usual practices of contracting and the labor laws of the governmental unit having jurisdiction. Any other procedure will inevitably tend to create the idea that the job is really one that has been provided primarily to make work and should be made to last.

Water Works Projects

In taking stock of the works that might be considered, it might be well to take a leaf out of the economist's book. It is a trite saying that, in the field of economics, as a country we have developed our production but that our facilities for distribution have not kept pace. This may well be said, too, of most water works. Consider the record. The great amount of construction work that has been done in the last few decades, at least that which has been brought most prominently to notice, has been in the more spectacular projects, such as dams, pumping and filtration plants, etc.—works that have for their object the production of drinking and industrial water. Most cities and towns have water mains. Since they have, why build more? That the pressure loss is high, simply means that a higher pressure must be developed at the pumping station, with higher power costs. But what members of the public ever look at a pressure gage anyway? If the cost of pumping goes up, it is simply a higher cost for which the superintendent is to be blamed.

Improved distribution facilities, larger mains, etc., will give better pressure distribution, lower friction losses, better fire protection. In many smaller places there is found a predominance of 4-in. mains running along parallel streets, connected at the cross-streets by short runs of 1½- to 2-in. pipes to supply the domestic consumers. If these smaller pipes are replaced with, for instance, 6-in. lines, an enormous increase in the capacity for fire flow will result. Hydrants may then be located in the center of the blocks served by the 4-in. lines and draw their supply from the 6-in. lines through the 4-in. pipes from two directions. The hydrant will thus be practically equal in capacity to one on a 6-in. main.

Many places have hydrants without individual valves. This indicates a needed improvement. Many older valves on the grid system may require overhauling. These are often the buried type accessible only through a simple valve box. In business districts, at least, valve boxes should be replaced by valve manholes. Old valves often do not hold. This is not easily discovered in the smaller plant till a sectional shut-off is required. The careful inspection, testing and repair of these older valves will provide a great deal of needed work. In the years past, some water works have installed valves without regard to the direction of opening. The changing of the spindles to provide for a standard direction of opening will be profitable.

A survey of the grid system will likely indicate where additional valves are needed. These will reduce the size of the area deprived of water in the case of a shut-off for repairs. This, also, is an important factor in the mat-

ter of air raid protection. Surveys can be undertaken, in co-operation with the sewer department as to likely extensions of services. These will be a guide to future subdivisions. Leakage surveys will usually indicate where further economies can be effected in pumping costs. Surveys of pressure losses in various parts of the system will indicate if main cleaning is needed. Correction of excessive pressure losses in this way will mean lower pumping power costs.

In cities without storage in the distribution system, the installation of elevated tanks should be studied. They will equalize the pressure and reduce power costs by permitting pumping to be done only on off-peak periods. Pump life will be prolonged and services will last longer under a uniform pressure. The supplying of fire department pumpers may be done in co-operation with the fire department. This can be justified on the basis of reduced service maintenance. Where pressure does not have to be raised with a fire alarm, the service pipes will be under a smaller stress and many pipes that would fail under boosted pressure will serve for years longer.

With a properly designed rate structure for fire protection, consideration should be given to installation of additional hydrants. Better fire protection will be obtained and the hose layouts in the case of fires will be much shortened. Fire insurance rates can thus be reduced in part payment for the improvement. Additional hydrants would be an important factor when protection against bombing was considered.

A metering program may be an effective way of postponing filter plant enlargements and at the same time of putting the merchandising of the product on a sound basis. In this way, too, power loads may be reduced and treatment costs lowered by the reduction in the amounts of chemicals required.

Frequently the maintenance department is inadequately housed. The provision of proper shops, conveniently located and designed, will increase efficiency and reduce costs. Bright and conveniently laid out meter testing departments should be provided. Handy storage facilities for meters and parts will repay their first cost.

There are still a few plants that take their supply from surface sources without adequate treatment. Softening equipment, particularly for plants using hard artesian water will usually provide a monetary return to the customer far in excess of the annual cost of the additional plant. This saving will be none the less real, though it is not reflected on the operating statements of the utility itself.

Water works property should be made attractive. The immediate surroundings may be parked and planted. Such a program will usually result in improved maintenance in the buildings, since attractively parked and planted surroundings will at once call attention to any deterioration in the buildings. This parking however should not be carried too far—a water works plant is a plant not a park. It exists for the purpose of producing water. Occasionally a situation arises where the park maintenance at a plant involves more work than the station itself. In such cases the important work of the station is inclined to be overshadowed. The cost of producing water is thereby thrown out of line since it necessarily includes a great deal of labor and other costs that are not properly incidental to the water supply project. Station planting and parking should exist simply for the sake of improving the con-

ditions at the plant. When they are carried out and maintained by the water utility out of water works funds simply for the sake of planting and parking alone they are out of place and are an unlawful expenditure.

These are a few of the many improvements that could be investigated as possible items of postwar improvement work in and around water works plants and in distribution systems. Other possibilities include: bringing up to date general maintenance work interrupted by the war; the scrapping and replacement of obsolete equipment; the replacement of obsolete office systems with modern methods; the rebuilding of stocks of materials depleted during the war; the expansion of reforestation and sanitation work on watersheds; and the development of additional or standby sources of supply. The alert superintendent will not be at a loss for possible useful work projects. The important thing is to have the surveys and the investigations made and the plans and specifications ready. When jobs come up for discussion and for possible negotiation with governmental authority, the complete information, costs, value, self-liquidating features, etc. must be quickly available.

Another possible provision for additional employment on a permanent basis will be the consideration of properly and equitably designed retirement schemes for elderly employees. At a time when the whole world is becoming social security conscious, studies should be made in this direction. Retirement schemes on a proper basis are not only a justice to the elderly employee with long service, but also an economy to the department. In most instances the new younger personnel will, after a very short period, reflect their presence in lower labor costs. It is not too much to say that this lower cost will, in the case of distribution service work, at least be more than sufficient to offset the department's share of the pensions.

Importance of Planning

Emphasis has been placed on the fact that in the great problem of reconstruction, water works improvements are merely incidents in reconstruction, relatively unimportant ones as far as they concern the provision of a great deal of labor during the acute period when many man-hours of work are needed. Even though this is true, however, the value of such work as may be provided will have an important effect on possible economies in the future annual operating budgets of the department. Water works officials should, therefore, be prepared to take their place in the matter of the provision of work opportunities of a useful character. As citizens, of course, they should study also the problem as a whole. This may not be the place to discuss it in detail, but an appreciation of the place of postwar water works improvements in the general picture will be necessary if the problems are to be seen in their true perspective.

Outline of Considerations for Evaluating Postwar Construction Projects

Excerpts From Material Developed by the James Committee

General

1. Will the project increase, directly or indirectly, the economic or industrial efficiency of the region concerned (or, that of the country generally)? Give details.

2. Has the project special relationship to additional works which may be necessary for the re-adaptation of industrial plant or other facilities of the district from wartime to peacetime uses? Give details.

3. Is the project concerned with amenities which increase productivity or which help to produce a revenue indirectly (such as, highways, waterways, pipelines or other transport facilities, communication facilities, certain conservation or land drainage measures, etc.)?

4. Is the project concerned with new construction, additional works or maintenance or repairs deferred owing to the war?

5. Will the project contribute to the welfare of the community (e.g., in the form of recreational, educational, cultural, public health facilities, etc.)? Give details.

6. (a) To what extent are locally produced materials and equipment available for the project? (b) Will the project compete with existing local industries?

7. In what other ways, if any, is the project of particular relevance or importance in this particular area?

Labor and Employment

8. What employment opportunities does the project offer during and after construction: (a) for skilled labor, (b) for semi-skilled labor, (c) for unskilled labor?

9. What is its relationship to probable unemployment in the region? Will it absorb labor previously engaged on war work?

10. What are the local circumstances as to labor supply available for the project? Is labor supply adequate or will extra labor be required? Has local labor other part-time employment?

11. What is the estimated labor cost of the project: (a) in respect to labor from local sources, (b) other sources? (*See* Financial.)

Financial

12. What is the total estimated cost? State date on which estimates are based. State time required to carry out project.

13. Is the project financed? If so, how? Will funds be required beyond one fiscal year? Is assistance required in loans or credits?

14. Give details of the most desirable building and financing plan, in respect to timing, for a construction period of up to five years. Show summary of estimated expenditure for land, labor, materials, equipment and administration broken down by years.

15. Will the project be maintained after completion by municipality, province, Dominion or other body?

16. Is provincial, municipal or private financing available? Give details.

17. To what extent is the project self-liquidating?

Technical

18. Has the project been subjected to engineering or other technical study and report? If so, attach copy of study or report.

19. Can an engineering or technical report be furnished, if requested? (If so, such report or reports should provide answers to the questions immediately following.)

20. What procedure has been followed in arriving at the estimate of costs?

21. What length of time will be required to complete all necessary plans and specifications?

22. Can work be undertaken promptly once the plans are completed? What preparatory work can be undertaken prior to completion of plans and specifications?

23. How much land is required? Is the land yet acquired? Need any other property rights be acquired?

Legal (Property)

24. Is land publicly owned or private property? Can land required, if private, be obtained by exchange for publicly owned land?

25. Are ordinances or enabling legislation or bylaws required? Have expropriation procedures been cleared? Does project conform to an existing or projected town, city or regional plan?

Grants-in-Aid

26. If a grant-in-aid is indicated, what controls are to be set up in relation to: (a) technical specifications, supervision and inspection during construction, etc.; (b) labor conditions; (c) expenditure of funds provided for the project; (d) maintenance after completion of the project?

Postwar Planning and Possibilities of Reduced Fire Insurance Premiums as a Factor in the Cost of Small Town Water Works Systems

By James R. McComas

ALTHOUGH the existence or absence of public water works systems in small residential towns has not, in general, constituted a problem of major concern in the past, they may, in the near future, warrant appreciable consideration. This may be particularly true in the inevitable wake or period of readjustment that must follow the present war. No doubt, thereafter, another public works program of super-magnitude will be initiated to cushion the blow of demobilizing labor and industry from its current peak of income and production back to the channels of peacetime.

The desirability of public water works systems in small towns is so obvious that little defense can be offered for their prevailing absence. Each prospective installation, taken independently, will offer only a small contribution to absorb local labor and consume materials made elsewhere by labor. Collectively, however, their labor-absorbing and material-consuming capacities are of major importance. It should be remembered too that the labor- and material-consuming factors do not terminate with the initial construction contract. Plumbing installations for the new bathroom, kitchen sink and cellar washtrays are then in the offing and, if carried to the point of completion, sanitary sewers and sewage disposal facilities follow.

A contribution by James R. McComas, Sr. Asst. San. Engr., State Dept. of Health, Baltimore, Md.

Selling the Public

Just how many small towns may be lined up to participate in any postwar construction program is problematical. Much will depend upon the manner in which the problem is handled. In connection it may be of interest to outline briefly the procedure which heretofore has been practiced in Maryland with gratifying results and to discuss the effectiveness of the several avenues of approach that were used, as well as the reactions thereto.

Generally, three factors of argument in favor of water works systems were used—public health, comfort and convenience and savings in fire insurance premium reductions.

The first, the absence of a public water supply, can invariably be translated into an actual or potential public health hazard. The reasons, therefore, are so obvious that their repetition is not warranted in this discussion.

Second, there is no valid reason why the residents of a small town should be without the comforts and conveniences which are a component part of a public water works system.

Third, the feeling of increased physical security for one's home that goes with a public water works system from the standpoint of fire protection is significant. It is an interest common to everyone because it affects his finances and the deep sentimental attachment he has for his home. Actually, it is the most effective avenue of approach in selling the idea of a public water works system in a small town.

The protection of one's health has an appeal to a majority of persons but, unfortunately, not to all of them. Convenience and comfort likewise have positive appeal, but usually are measured in relative terms and, therefore, are not fully appreciated except by those who have experienced the benefits thereof. The saving in fire insurance premiums appears to be the common denominator that is of interest to property- and homeowner. The ·m then is to present concrete evi- ... that the savings in fire insurance premiums, prorated to each home, are sufficiently significant to offset materially the annual cost of financing a water works system. Unfortunately, until a water works system is actually installed, no positive data can be presented to show that the various fire insurance companies will reduce fire insurance rates by a predetermined amount. If such information could be disclosed, based upon data supplied by the rate-making agencies, undoubtedly the presentation would be more effective. To say the least, it would be accepted without skepticism. At present, the only alternative is to present the amount of reduction that has become operative in similar nearby towns, which previously were without public water works systems, subsequently installed them and then received significant reductions in rates as applied to residential properties.

Developing and Presenting the Data

In Maryland, the engineering staff of the Bureau of Sanitary Engineering, in order to assist the smaller towns, adopted the program of making the necessary field surveys and prepared engineering drawings sufficiently complete to develop an accurate cost estimate for discussion with the local town officials as to the capital cost involved. Through public meetings and conferences with the town officials, the desirability and the results that follow the installation of a public water works system were discussed in detail. Invariably the item of common interest was the savings that might be effected in fire insurance premium reductions, or the net cost per year per home. The capital cost was generally reduced to and presented in terms of annual cost for amortization and interest for the indebtedness that would be involved. This, in turn, was reduced to the proportionate cost to an individual home of average value, so that each interested homeowner would know, more or less specifically, how much additional cost would be imposed upon him in the event the town elected to proceed and become financially obligated as required. From this proportionate tax, the homeowner could by a simple arithmetical calculation deduct the savings effected by fire insurance premium reductions to arrive at the net annual cost to him.

TABLE 1

Financing Annual Charges of Bond Issue and Methods of Acquiring Same
Estimated Cost of Project = $35,000

Fixed Charges

$35,000 in 2½% Serial Bonds. One bond to mature each year.

First Year

Interest $35,000 at 2½%	$ 875.00
Maturity, First Bond	1000.00
Total Annual Charge	$1875.00

Last Year

Interest $1000 at 2½%	$ 25.00
Maturity, Last Bond	1000.00
	$1025.00

Mean Year

($875 + $25) ÷ 2 + $1000 = ... $1450.00

Sources and amount of charges for first year must equal or slightly exceed $1875; for last year $1025, etc.

Tax Basis (Assessable)	Frontage—Feet			Services	
	Residential	Business	Small Acreage		
$500,000	7750	1520	1350	120	
$0.06	$0.10	$0.20	$0.02	$4	
$ 300	$775	$304	$27	$480	Total = $1886
Application to a residence assessed at $4000 occupying a 60-foot lot					
$ 4,000	60				
$0.06	$0.10			$4	
$ 2.40	$6.00			$4	Total = $12.40

That is to say this property would pay $12.40 the first year and progressively pay less each year until the last year when the charge would be in the ratio of $\frac{1025}{1875} \times \$12.40$ or $6.77

Probable Savings in Fire Insurance Premiums

$4000 residence; insured for $3000 at a reduced rate of $0.20 per $100 = $6.00

Probable Net Annual Cost:	First Year	$12.40 − 6.00 = $6.40
	Mean Year	9.59 − 6.00 = 3.59
	Last Year	6.77 − 6.00 = 0.77

Operating Charges

This property would also pay, toward maintenance and operation, a charge of possibly $0.20 per 1000 gal. of water used, or on some equivalent basis.

Assuming 50,000 gal. per year per average family—50 × $0.20 = $10.00.

Net Annual Cost:	$12.40 +	$10.00 −	$6.00 =	$16.40 First Year
	9.59 +	10.00 −	6.00 =	13.59 Mean Year
	6.77 +	10.00 −	6.00 =	10.77 Last Year

For the maximum (first) year this is equivalent to $16.40 ÷ 365 = 4½ cents per day which is less than the price of a pint of milk or a small loaf of bread.

Table 1 shows a typical method of arranging these preliminary data in the interest of making the material clearly understood by the layman. In order equitably to assign costs to each property of the several classifications according to the benefits derived and to differentiate between fixed and operating costs, the assessments or annual charges were presented as a combination of general property tax, annual front-foot assessment for the term of the bonds, cash payments for service connections, including meters if installed, and water consumption charge. This arrangement is far more equitable, when properly balanced, than the general real estate tax that, for convenience and simplicity of bookkeeping, is too often resorted to in small towns. Further, with a tax program ever increasing in every denomination and description, further tax increases on real estate, "agin" which there always was resentment, must be avoided where and when a rational application permits a more equitable basis.

It is believed that this method of differentiating costs and allocating charges, which, incidentally, has been operative in a number of places in Maryland * for the past twenty years or longer, overcomes many of the obstacles of financial objections entertained by those not too familiar with the mechanics of financing public projects.

It is to be regretted that fire insurance premium reductions, which constitute the most effective sales method, must be used comparatively, because specific or even tentative rates of reduction are not made available until after a water system has been installed. In this connection, it may be of interest to those active in the field generally, or to citizens interested in a specific village, to have available recent statistical data relative to nearby local towns where water works systems have been installed and to use these comparative data in their presentation. Table 2 includes a partial list of such towns in Maryland. The data are arranged to make all items comparable.

It should be borne in mind that, if a bond issue for a public water works system is subjected to referendum by the local voters, the decision depends upon a majority of the homeowners and others voting "for" and not "against" it. In purely residential towns, this is merely a percentage procedure. In other towns it is possible that a mill, factory or similar structure may represent a large proportion of the assessable basis of a town and that its demands for fire protection far exceed the requirements of a reasonably adequate system to provide domestic service and fire protection for the residential property. There is no valid reason why, therefore, such a town should be without a public water supply merely because its constituents cannot finance one adequate in magnitude to protect it "creditably" and to reduce insurance rates appreciably for the mill, factory or other similar structure. Actually, the owners of such industrial properties have a specific appreciation of the protection afforded by a water works system, but, unless they are personally benefited, they invariably discourage an installation sufficient to provide protection to the residential areas only. They are either already protected by

* Wolman, Abel & Morse, R. B. A Plan for Meeting Water Supply and Sewerage Cost. Eng. News-Rec., **86**: 944 (1921); Wolman, Abel. Municipal Water and Sewerage Costs in Maryland. J.N.E.W.W.A., **41**: 439 (1927).

their own industrial system or interpret the cost as an undue burden on their property. This obstacle, of course, must be overcome and included in the necessary calculations as they are presented for public consideration.

In reviewing column 3 of Table 2 it is interesting to note the differential rates that applied in the towns listed before water works systems were installed. To one familiar with the locations of the towns listed, it would appear that the grouping of the several rates is geographical. From the author's knowledge of the individual towns, it does not seem possible that the fire hazards in towns H and I, as compared to those in towns A, B and C, were previously in the ratio of 65 to 37 or almost double. It would be interesting to know if this ratio was deduced from facts. Similarly, it does not appear that towns H and I with their "protected" 33-cent rate, as shown in column 4, remain almost as hazardous as the three other towns with their "unprotected" 37-cent rate. The mere fact that the rates for towns H and I were reduced by almost 50 per cent would suggest that their water works systems tested satisfactorily and accordingly were so credited. On the other hand, could it be possible that the original unprotected rates were basically too high and an appreciable reduction was due? Such data are difficult to interpret and must be used with caution and reservation. Aside from the installation of the water works systems these towns remained *status quo* as far as other items of credit or deficiency are concerned.

It is recognized that the continuity of operation of the several types of systems supplying the towns listed depends upon many different factors which may justify, to some extent, the differential in credits given. This does not, however, account for the wide range of difference in the "unprotected" rates or for the present "protected" rates.

TABLE 2

Comparative Data on Fire Insurance Rates for Nine Maryland Towns With and Without Water Works Systems

Town	(1) Pop. 1937	(2) Approx. Assessable Basis Real. & Per.	(3) Fire Insurance Rates per $100	(4)	(5) Percentage Reduction in Rates	(6) Total Cost of Project
			Unprotected	Protected		
			¢	¢	%	
A	1145	$629,782	37	25	32.4	$48,801
B	712	645,000	37	25	32.4	28,034
C	278	240,000	37	23	37.8	38,099
D	540	291,300	40	23	42.5	26,602
E	496	316,780	50	34	32.0	38,826
F	445	500,000	55	30	45.5	36,500
G	737	369,370	59	27	54.3	46,076
H	361	111,476	65	33	49.3	23,256
I	349	153,000	65	33	49.3	15,455

Importance of Planning

No reference has been made in this discussion to the fact that funds for the capital costs in a number of these towns were reduced by either 30 or 45 per cent through grants from the Public Works Administration. Although this factor materially reduced the actual amortization costs it was an abnormal condition and has not been used in the data presented herewith. In the event that a similar public works program becomes operative after the present war, there is no doubt capital costs will be reduced by some sort of grant or domestic lend-lease which can be effectively used in specific instances. Using the Public Works Administration program as an index, it may be assumed that those towns which are ready to proceed will be given first consideration. It will be imperative, then, that they have contract plans and specifications ready for immediate action or be in a position to have them prepared promptly. The usual delay that occurs in small town activities must be overcome.

Water Works Accounting Practices in Canada

By C. W. Eastwood

IN discussing water works accounting, Carl H. Chatters, Executive Director of the Municipal Finance Officers Association, has said that, if people contracted typhoid fever because of poor water works accounting practice, more attention would be given the subject. It is known that the water plant does deteriorate in time; and Mr. Chatters maintains that, although people may not die because of inadequate accounting, the resulting faulty fiscal management may permit the unnecessary expenditure of large sums for operation and maintenance. It is, therefore, important to consider the place and purpose of the accounting office in the general water works organization.

The first purpose of an accounting system, of course, is to record the investment in land, structures and equipment, together with organization expense, etc., in such detail as may seem desirable; then to compile, in suitable accounts, a record of receipts and expenditures as time goes on. A good accounting system is one which provides for recording financial data in such a manner that they can be utilized effectively as a guide in managing the plant, as a basis of checking the fidelity of persons administering funds and as a means of informing the officials and public of the existing financial condition. It need hardly be mentioned that certain phases of utility operation would indeed be difficult, if not impossible, without the aid of financial information. For instance, to be workable, a utility budget must be based on past experience, as reflected in the financial reports of previous years, while the management must know the financial condition of the utility and must be aware of the current changes in that condition.

Otto K. Jensen, State Accounting Examiner for Indiana, has pointed out * that superintendents and accountants have much the same duties to perform. For the one, legal limitations of procedure may be more strict than for the other, but their aim is the same—to operate the utility to the best advantage, giving the service demanded by the public at the least possible cost and keeping the operating properties at the highest point of efficiency. The need for a superintendent is well recognized, but there is a tendency to disregard or underestimate the value of an accountant. Some think the only purpose of an account-

A paper presented on April 8, 1943, at the Canadian Section Meeting, Hamilton, Ont., by C. W. Eastwood, Office Mgr., Public Utilities Com., London, Ont.

* JENSEN, OTTO K. Relation Between the Water Plant Superintendent and the Accountant. Jour. A.W.W.A., **34**: 849 (1942).

ing system is to show that cash has been placed in the bank and that the cash balance is sufficient to cover purchases which must be made. Mr. Jensen further states that, in making his audits, he gets the impression from many utility officials, that they believe accounting records to be necessary for the auditors examination, but that that is their sole purpose. These officials forget that the reports required are nothing more nor less than a summary of the records of their operations and that proper accounting gives a picture of the business.

It may well be suggested here that, just as the accountant should know something of the plant, the superintendent and others who are required to furnish information to the office should have at least a little knowledge of the accounting system.

Superintendents may complain that they can never get the information they want from the accounting department. This is often the case, but often the fault lies with the information or misinformation given by the superintendent to the office. The superintendent is the one who directs the work and knows all the facts, so that it is he who must make the distribution of time and material to the proper account. Not only should he be familiar with the classification of accounts, but he must have enough knowledge of accounting to understand what information is needed by the accounting office. It is his duty to see that the accountant is furnished the correct data.

On the other hand it is the accountant's duty to adopt the viewpoint of the water works executive to ascertain that the classification of accounts is so arranged and divided that reports can be prepared that will reflect the existing condition. If the needs of the executive are provided for, any requirement of any government body can be met without difficulty. The effectiveness of the accounting system is measured by the use made of the information supplied by the accounting system. The facts recorded on the books assume their greatest value only when translated into reports which form the basis for some constructive action.

Unified Classification of Accounts

Many articles have been written on water works accounting and there seems no doubt that the standardization of this subject is more advanced than other phases of municipal accounting. In 1938, in the preparation of the *Manual of Water Works Accounting,* published jointly by the Municipal Finance Officers Association and the American Water Works Association, two primary essentials were recognized—a standard classification of accounts and a common terminology. Apparently the latter was the more difficult on which to reach an agreement.

In 1942, another attempt to secure a uniform classification was made, this time in Canada. The Dominion Bureau of Statistics set up a committee headed by its Chief of Finance Statistics and including financial experts from all over Canada. It published a *Manual of Instruction,* one copy of which is sent free to each Canadian municipality. This manual sets forth a classification of accounts for each municipal activity—that for water works following fairly closely the *Manual of the Hydro-Electric Power Commission of Ontario* for municipal electrical utilities. A section on municipal accounting terminology was also

included. This manual is worth study by all commissioners, managers, accountants and superintendents who are anxious to prepare reports and statements that will provide a means for true comparisons and for control and progress.

Some years ago, the London (Ont.) Water Works Department, lacking any other model, adopted a classification parallel to that of the *Manual of the Hydro-Electric Power Commission of Ontario*. Many other Ontario municipalities have adopted the same means of setting up classifications. It would be of great value, of course, if the Canadian water works accounting could be standardized. If this were done, not only could the reports of individual water works be compared with their reports of previous years, but, more important still, each water works could compare its reports with those of other municipalities, knowing with confidence that it was comparing as nearly as possible similar operations.

Under present methods, even if a water works adopts a uniform classification of accounts it is still not able to compare statements with those of other plants, for there are two systems —the cash system and the accrual system—in use for making entries to the ledgers. The first is the method of making the entries at the time the goods or materials are paid for; the second, that of making the entries in the month in which the materials are used. Similarly, in the cash system, revenue from customers' bills is posted when the cash is received, but, in the accrual system, the revenue is posted in the period of use. The cash system really produces a statement of receipts and disbursements, but the accrual system produces the much more useful and proper system of revenue and expense. It is to be recommended to those who are still using the cash method.

Depreciation and Replacements

A discussion of the cash and accrual systems raises the problem of depreciation reserve. The value of the accrual system is that it gives a true picture of the financial situation for any given period. Unless a depreciation reserve account is set up, however, replacements will have to be charged to operating accounts at infrequent intervals without any uniformity. For instance, because London has no depreciation reserve account for the Water Works Department, annual replacement charges to operating accounts have, in the last ten years, varied all the way from nothing to $25,000. The actual wear and tear on the equipment represented by these charges has been fairly uniform, whereas the charges themselves have been most erratic. The result is that the annual statements do not give a true picture of the cost of operation from year to year.

Neither the Ontario Public Utilities Act nor, as far as the author is aware, the special water works acts give authority to set up a depreciation reserve account such as is provided for by the Power Commission Act. The *Manual of Instruction* of the Dominion Bureau of Statistics, however, does consider depreciation and gives a definition of "reserve for depreciation" as follows: "The accumulation of periodical credits made to record the estimated reduction in the value of certain assets, due to wear and tear through use or obsolescence." If such a fund were established, a more or less uniform sum, calculated with some degree of accuracy, could be set

aside from year to year, to represent that year's wear and tear, and all expenditures for replacement could be charged to this fund, thus giving a truer and more uniform picture of actual conditions during any single year. Statements produced on this basis would be of some real value as a basis for water rates to customers and to adjacent municipalities.

Customer Accounting

Customer accounting—billing and collecting—must also be taken into consideration, since it is this phase which actually deals with the source of revenue. In this division of accounting, the office must have:

1. A complete record of all essential information
2. A method of determining consumption at regular intervals
3. A method of billing each customer and keeping proper records of the amount due from each
4. A method of ascertaining that customers pay their bills
5. A method of providing for prompt recording of the collection and proper crediting of each customer
6. A method of supplying the management with such customer accounting data as may be required or desired
7. A method of supplying the general accounting department of the office with summaries which can be used as a basis for making the necessary entries in the general accounting records.

The procedure involved in accomplishing this in London is initiated by the customer when he signs a written application for service, i.e., a contract. This application form records the correct address and the meter number at that address, as well as where the customer moved from and, later, where he moves to. From this application an address plate is made and filed properly and the meter reading card or record is changed. The form then goes to a "Kardex" cabinet and is filed by street and number.

The meter reading card follows the address; it shows the location, serial number and other vital information regarding the meter. The card is designed to last six years, readings being entered from the bottom up, for ease in finding consumption. Thus, the correction of the consumer's name is the only change required during the life of the card. Readings are taken bi-monthly and, as nearly as possible, on the same date.

Meter readers record the reading on 4×9-in. cards. They carry the cards in a pouch and have them arranged in routes. The cards for the route worked on, of course, are carried in the hand and, as a reading is entered, the card is moved to the back of the pack, thus providing a continuously firm writing surface. The cards for any missed readings are pulled and given to a skip man the next day. If the skip man is unable to gain entry to read the meter, he leaves a dial-inscribed postcard for a customer reading. It should be explained that, when the meter reader cannot get a reading, he endeavors to ascertain from the neighbors if the consumer is away and when he went away. He indicates this on the card so that an estimated consumption may be billed. Such bills are put in the mail as are all estimated consumption bills, made when the postcard is not returned within 24 hours.

From the meter card, the bill which has been addressed, is prepared on a "Burroughs" machine. The stub rather than the ledger card plan was adopted after considerable investiga-

tion, because it gave the desired capacity combined with flexibility. It does not provide the continuous customer record of the ledger card plan, but new ledger cards have to be prepared each year or two at the least, while the meter card is good for the six years. The ledger card is an advantage, of course, in dealing with the delinquent account, but is of no particular advantage for regular operations; so that it seems rather fruitless to build a system around a condition existing in only 10 to 15 per cent of the accounts.

All bills are delivered by hand, except the few which require mailing. All payments received are deposited in the bank the next morning, after proper entries are made to the accounts receivable control account. At the same time, cashiers' stubs are sorted and, in the posting operation, payment is indicated on the ledger stub. After a tally is taken, the ledger stub is removed from the file leaving only the unpaid accounts.

Reminder notices are mailed five days after the discount period expires and final or shut-off notices, two weeks after that date. Copies of the latter go to the Collection Department for action if the account is not settled within 48 hours.

As a byproduct of the billing operation, a recapitulation is obtained. This permits proving the computations on sixty bills at a time. From this accumulation, the accounts receivable control is charged and revenue is credited. This method takes the revenue into account in the period it was earned. This byproduct, of so-called proof sheets, consists of carbon copies of all bills. From them various consumer statistics are also obtained.

In addition to the above outline of the plan in use at London, it should be mentioned that an effort is made, in choosing clerks for the various customer contacts, to pick those who know the system and who are capable of using diplomacy and tact. The forms used are designed for ease of understanding and operation.

Recommendations

The general principle followed in arranging the work of the employees in an accounting office is to make the duties of each complementary to that of the others, thus establishing a series of interlocking checks or audits. For instance, meter readers should have nothing to do with billing. Billings should be proved by persons other than those doing the actual billing. Persons making entries to individual customers' account should not make entries to accounts receivable control accounts and persons keeping accounts receivable should have nothing to do with collecting or handling cash. All incoming mail should be opened by a responsible employee.

Deposits: Some problems are common to all water works, no matter what accounting system is used. The handling of customer deposits is one such problem. Since such deposits are not revenue, good accounting practice suggests that the funds be deposited in a separate bank account. Many authorities recommend that bank interest be allowed on them. Since some municipalities accept deposits, hold them indefinitely and, in some cases, are known to have deposits from consumers now deceased, it is also recommended that these deposit accounts be reviewed at regular intervals and refunds arranged where consumers have established satisfactory credit records.

Discount Dates: There is considerable merit in the practice of a fixed discount date on bills, as recommended by the *Manual of Water Works Accounting*. In London, these dates are varied to miss Sundays and holidays, because of which many consumers are caught when the due date is moved up one or two days from that on the previous bill. The recommended plan provides for making the discount expire on the same date each bill, with provision for accepting payment on the Monday or day after a holiday. With such a plan in effect, the customer gets the due date fixed in his mind and can plan the distribution of his income, knowing with assurance just when he has to provide for his next bill. The annoyance of and objection to having a bill come in after his payday and the discount day expiring before his next payday is overcome to a large extent when the due date is not varied.

In passing, it should be mentioned that in London a regulation has been made permitting a consumer to recover lost discount by prepaying his next bill, that is, to the amount of the last one, a month in advance.

Banking: A troublesome item in banking is the returned "N.S.F." check. A number of these are, no doubt, mailed to reach the office by the due date with the hope of saving the discount. Since some days elapse before the cash can be collected for them, the discount should not be allowed. Such checks should be recharged to the consumer's account and the account treated as though overdue. To say the least, it is not fair to those whose checks are good or those who come in late with cash and pay the discount.

Of course all cash and checks received by the cashiers should be deposited in the bank the next day. Then all receipts for a period will tally with the bank deposit and may be so audited. All withdrawals will be by check, but to facilitate the payment of small items such as freight bills, etc., and to make up cashiers' change, a petty cash fund should be set up. This is done by issuing a check to a responsible office employee for a suitable amount and for which he or she will be continually responsible. At regular intervals the bills which have been approved and paid from this fund are gathered and a check issued to cover them and thereby to reimburse the fund.

Work Orders: Another valuable adjunct to the accounting system will be found in the installation of a supplementary ledger to which all special maintenance or construction work is charged through a system of work orders. In other words, when any job is started, costing more than, for instance, $50, a work order is issued for that job and given a number. To this job or account number will then be accumulated all items of time and material and other expenses, no matter from what source. When the job is completed the total cost of it is then ascertained and can be compared with the estimate. It is subsequently transferred to the main ledger account under its proper classification.

The intelligent interpretation of cost reports or work orders, which are accurate and timely, will disclose the efficiency with which resources are employed. It will fix the responsibility for inefficiencies and, by keeping the record of units used, the order becomes very valuable for future estimates.

Surface Washing of Filters at Orrville, Ohio

By James E. Specht

THE municipal lime-alum water softening plant for the village of Orrville, Ohio, was built during the early part of 1939 and was placed in regular operation in September of the same year. While the plant has a nominal design capacity of 360 gpm., it has operated most of the time at rates between 400 and 450 gpm., as a matter of necessity and economy. Normally the plant operates at either of two nominally constant raw water input rates of 90 gpm. and 450 gpm., the higher rate being cut in and out automatically by a float controller switch in the clear well.

The softened water has been well received by the consumers, as evidenced by a 44-per cent average increase in water production in a little over two years' operation of the plant, rising from an average of 306,000 gpd. to 441,000 gpd. In fact, during August and September 1942, average plant production increased still further to 510,000 gpd. From the standpoint of plant operation this means simply that, during many days of the month, the plant operates between 20 to 24 hr. at the high rate. This load of course has placed a severe strain on the sand filters, of which there are three, each 6 ft. $\times$ 10 ft. in size, of conventional design, containing 18 in. of gravel in the bottom, covered by 24 in. of filter sand, with a 6-in. clear space left below the steel wash water trough.

Installation of Agitator

The plant had been in operation only a few weeks when it was noticed that the sand levels in the filters had risen nearly to the bottoms of the wash water troughs. Since the maximum wash water rate, a 24-ipm. rise, was already being used, it was decided to try increasing the washing time. This procedure, however, had no appreciable effect on the rate of rise in the filter sand levels, so that it was soon found necessary to drain and clean each filter on the average of every three to four weeks. This meant that a man had to get down into the filters and shovel out at least 2 in. of the white granular sand-like material resting on top of them. Subsequent analysis showed this granular material to consist almost entirely of a central sand particle covered by calcium carbonate scale, in amounts by weight of 20 per cent sand and 80 per cent lime scale.

After fifteen months operation it was decided to make a trial "Palmer" filter agitator installation in one of the filters. The unit was accordingly ordered and installed in January 1941,

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6 in. of filter sand being removed to accommodate the agitator unit.

Operation of the agitator consists of turning it on for 1 min. before starting to backwash the filter, then turning it off about 2 min. before the backwashing is completed. Being supplied with city water at 80 psi. pressure, the agitator functioned perfectly.

Operating Results

The beneficial effect on the filter sand was so great that it was thought for a while that the sand growth had stopped entirely. As a result, additional agitators were purchased and installed in the other two filters by June 1941. Although the agitators did not actually completely eliminate the filter sand growth, they were instrumental in reducing the growth about 80 per cent, so that it is no longer necessary to remove the white granular material oftener than once every four months. This improvement has taken place in the face of a 44-per cent increase in water production and has almost eliminated the disagreeable and time-consuming job of scraping the filters. Although many operators would not consider this time-saving an important factor, it looms large in a small plant, where a single operator must take care of all operations—which, in Orrville, involves cleaning, sampling, handling of chemicals, mixing of solutions, greasing and checking of pumps and mechanical equipment, besides making daily checks on two wells three miles away and a cathodic protector unit in the downtown elevated storage tank.

After some months of satisfactory operation, an unexpected difficulty arose, when the nozzles in the agitator arms plugged, slowing down the agitators and greatly decreasing their effectiveness. Since these nozzles each have $\frac{1}{8}$-in. diameter openings they were easily cleaned by means of an icepick, but this did not, of course, solve the problem. In seeking the cause of the difficulty, it was at first assumed that an internal scale was being built up in the nozzles. Fortunately the nozzles were of the simple screw-on type, so that they could easily be removed for examination and cleaning. Upon doing this it was found that instead of being scaled, the nozzles were tightly packed with the same lime-coated sand particles as those found building up on top of the filters. Assuming, then, that these lime-coated sand particles were somehow being floated or washed into the agitator assembly during the last stage of the filter backwashing procedure, after the high pressure water to the agitators had been shut off, it was decided to leave the agitator water supply valve cracked until backwashing was completed. Although the operator now removes all agitator nozzles once every two weeks he very rarely finds any plugged, except for one nozzle in each arm, immediately below the stationary mounting head, which is invariably found tightly packed. To date no explanation of this apparent inconsistency has been found, although it is suspected that, since the particular nozzle in the hub of each agitator is several inches lower than those in the pipe arms, it is simply a matter of closer proximity to the sand.

Backwash Problems

Normally, these filters have been free from hard spots, although, while the regular operator was off duty during September 1941, his substitute's failure to backwash the filters long enough did result in the formation of

a large hard spot in the corner of one unit. Careful backwashing and the regular use of the agitator unit have been instrumental in reducing this hard spot to the size of a sheet of paper. It was thought that sooner or later the spot would disappear entirely, but at present (April 1943), almost a year later, apparently very little or no further size reduction has occurred. It must, therefore, be assumed that the nucleus of this hard spot had been solidly cemented together at some previous time and that its final removal must await the first regular rebuild and overhaul job on the particular unit.

Although several attempts have been made to reduce the amount of wash water used, thus far this has been found relatively impractical, doubtless due, in good measure, to the continued high rate of plant production at values approaching ultimate capacity. There is every reason to believe that it may be impossible to reduce backwashing water consumption and that it may even be desirable to increase the amount in order to take full advantage of the scrubbing and dirt-loosening properties that characterize the operation of the filter agitator units. The operator reports that the wash water becomes clear in a somewhat shorter time when the agitators are not in operation, whereas when they are functioning he finds it necessary to continue backwashing several additional minutes. The obvious conclusion is that the use of the agitators has resulted in keeping the filters cleaner and in better operating condition and has materially cut filter operating and maintenance costs.

Estimation of High Chlorine Residuals

By A. E. Griffin and N. S. Chamberlin

AS old a practice as it may seem, it was not until 1925 that references to the chlorination of new mains began to appear in the literature. Thereafter, the application of chlorine to water mains became so widespread that a survey (1) conducted in 1937 found a majority of the state sanitary engineers in the country recommending that such a procedure be made routine.

Using bacteriological results as a criterion, it was found, over the intervening years, that satisfactory sterilization of water mains could be accomplished only by high applications of chlorine. Based upon this experience the A.W.W.A. Committee on Laying Cast-Iron Pipe in 1938 recommended (2) that newly laid pipe be charged with water containing 40–50 ppm. of chlorine.

With the advent of the present war and the bombing of England, main and emergency sterilization took on a new and more serious significance. In fact, Berry (3) infers that water works personnel are expected by the public, and rightfully so, to continue at all costs the service of water for domestic consumption, for sanitary requirements and for the vital industrial and fire-fighting needs in every section of every hamlet, town or city, no matter how trying the conditions. Mackenzie (4) states that the need for water in wartime is so great that the delay caused by following the usual procedure of waiting for satisfactory bacteriological results must be avoided. Under such circumstances reliance on quick, decisive sterilization becomes totally dependent upon heavy applications of chlorine. The necessity for this procedure became apparent when the English realized that sewage pollution is often hard to detect.

It is evident that the method for determining high chlorine residuals must be quick and easy to manipulate, for, of necessity, it will often be used in the field under very trying conditions. It is also of utmost importance that the method be reliable, giving a foolproof answer, and one that does not lead water works men to *think* they have the desired chlorine residual, but to *know* that they have it. Ortho-tolidine is ideally suited for this purpose.

All who have used ortho-tolidine have noted that yellow colors, comparable to existing permanent chlorine standards, are obtained with low chlorine residuals, but that, when the chlorine content is high (above 20.0 ppm.)

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and the procedure for the determination of low chlorine residuals is followed, a "cherry" red is produced. As a result, it has often been stated that the cherry red color is a reliable index of high chlorine residuals.

The purpose of this discussion is to demonstrate the fallacy of the cherry red color as indicative of high chlorine residuals; how this criticism can be constructively used to devise methods for determining such residuals quantitatively; the chemical reactions which confirm these findings; and, finally, the methods themselves.

Fallacy of Cherry Red Color

The prevalent opinion that the cherry red color is an index of high chlorine residuals is based upon the widespread use of the two methods given in *Standard Methods* (5). One method—that of using 1.0 ml. ortho-tolidine per 100 ml. water—is specific for chlorine residuals not greater than 1.0 ppm. and the other—that of using 5.0 ml. ortho-tolidine per 100 ml. water—is specific for chlorine residuals between 1.0 and 10.0 ppm. When these amounts of ortho-tolidine are added to two 10-ppm. chlorine samples, it is noted that a cherry red color is formed in the one to which ortho-tolidine is added at the lower rate and that the familiar yellow ortho-tolidine chlorine color is formed in the one to which ortho-tolidine is added at the higher rate. That the cherry red color is an index of high chlorine residuals is apparently in error, for the method specifically prescribed for the 10 ppm. chlorine residual gives the characteristic yellow color. The fallacy of the cherry red color lies in the fact that it was produced by the method applicable only to chlorine residuals up to 1.0 ppm. Muer and Hale (6), in working on chlorine residuals up to 10 ppm., called attention to the fact that the red color was erroneous, in fact a danger signal. They pointed out that the cherry red color was not an index of high chlorine residuals but a warning that the amount of ortho-tolidine was insufficient. They prescribed the use of five times as much ortho-tolidine for chlorine residuals up to 10 ppm. and, in so doing, obtained the correct result observed in the above demonstration.

How totally misled one can become by setting up the cherry red color as an index of a high chlorine residual, e.g., 20, 30, 40, 50 or 100 ppm., is shown by adding ortho-tolidine at the rate of 1.0 ml. per 100 ml. of chlorine water to a series of samples containing 10, 25, 50, 75 and 100 ppm. of chlorine. It is noted that the cherry red colors formed in each are of the same intensity and that, as the color precipitates out, the quantity in each sample is identical. These red colors are the result of some chemical constant added to, or present in, the water, since the same amount of color or precipitate is present in each. The constant is the ortho-tolidine. The cherry red color is therefore not only indicative of insufficient chlorine, as shown in the first demonstration, but is actually a quantitative measure of the amount of ortho-tolidine used in the test. Certainly there is no desire on the part of the analyst to determine the amount of ortho-tolidine being used in a chlorine residual test.

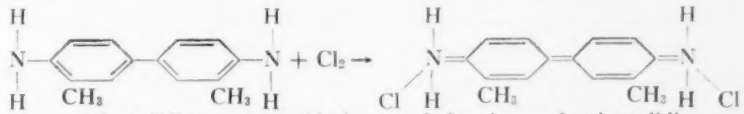
Quantity of Ortho-tolidine

The quantity of ortho-tolidine required for obtaining the quantitative yellow holoquinone color can be ascertained in a number of ways; e.g., the methods for determining chlorine residuals in *Standard Methods* can be

used. Upon examining the first method—that for chlorine residuals up to 1.0 ppm., where 1 ml. of ortho-tolidine per 100 ml. chlorine water is used—it is found that the yellow holoquinone color will persist with increasing chlorine residuals until $3\frac{1}{3}$ ppm. has been reached. At values greater than this, the color becomes orange and finally red, indicating that 1 mg. of ortho-tolidine (the amount contained in 1 ml.) can form the yellow holoquinone color just so long as the amount of chlorine present does not exceed $\frac{1}{3}$ mg. (100 ml. of a $3\frac{1}{3}$-ppm. chlorine residual); i.e., just so long as the ratio of ortho-tolidine to chlorine by weight does not become less than 3:1. Similarly, the second method—that for chlorine residuals up to 10.0 ppm.—shows that 5 mg. of ortho-tolidine (the amount contained in 5 ml.) can form the yellow holoquinone color just so long as the amount of chlorine present does not exceed $1\frac{2}{3}$ mg. (100 ml. of a $16\frac{2}{3}$-ppm. chlorine residual); i.e., again, just so long as the ratio of ortho-tolidine to chlorine by weight does not become less than 3:1.

That the ratio of ortho-tolidine to chlorine by weight must be at least 3:1 to form the holoquinone is further demonstrated by adding to 10 ppm. of chlorine, ortho-tolidine in varying quantities, so as to give ratios of ortho-tolidine to chlorine by weight of 1:1, 2:1, 3:1, 10:1 and 100:1. It is to be noted that the cherry red color is formed with the 1:1 ratio, a deep orange, almost red, color with the 2:1 ratio and, beginning with the 3:1 ratio, the yellow holoquinone color. It is also observed that the yellow holoquinone colors of the 3:1, 10:1 and 100:1 ratios are the same. In quantitative colorimetric methods, the same colors should be developed just so long as there is a sufficiency or an excess of the reacting reagent. In this case the reacting reagent is ortho-tolidine. In giving the same colors with the 3:1, 10:1 and 100:1 ratios of ortho-tolidine to chlorine by weight, ortho-tolidine has behaved as, and met the specifications of, a reacting reagent for the determination of high chlorine residuals.

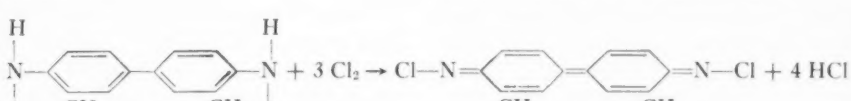
Another method of ascertaining the quantity of ortho-tolidine required for the quantitative determination of high chlorine residuals is afforded by a review of the reactions giving the yellow holoquinone and cherry red color of ortho-tolidine. Chlorine is known to react with ortho-tolidine to form the holoquinone of that compound. The word holoquinone immediately suggests the type of reaction involved, for "quinone" means that the ortho-tolidine is converted to the quinoid form and "holo" from the Greek word *holos* (7) for fully, means that the ortho-tolidine is fully oxidized to the quinoid form. The reaction which accomplished this purpose is:



This reaction shows that 1 mol of ortho-tolidine, or three gravimetric units, reacts with 1 mol of chlorine, or one gravimetric unit, to form the holoquinone. For all of the chlorine to react with the ortho-tolidine and,

thereby, to produce a color proportional to the amount of chlorine present, it is essential that at least three times as much ortho-tolidine as chlorine by weight be present. This confirms the previous observations on the quantity of ortho-tolidine required to produce the proper color.

In the demonstrations presented thus far, it has been shown that, when the ortho-tolidine-chlorine ratio becomes less than 3 : 1, the yellow holoquinone color becomes orange. This is suggestive of a mixture of the yellow holoquinone and the cherry red color. When the ortho-tolidine-chlorine ratio of 1 : 1 is reached and passed, the true cherry red color prevails. Since the holoquinone color is gradually changed over to the cherry red color by decreasing the quantity of ortho-tolidine or increasing the quantity of chlorine in successive samples, it can be assumed that the cherry red color is a chlorine-substituted derivative of the yellow holoquinone. The reaction involved in the production of this cherry red color is:



ortho-tolidine chlorine chlorine-substituted holoquinone

This reaction shows that $\frac{1}{3}$ mol of ortho-tolidine, or one gravimetric unit, reacts with 1 mol of chlorine, or one gravimetric unit, to form the chlorine-substituted holoquinone (8). For all of the chlorine to react with the ortho-tolidine and, thereby, to produce a cherry red color proportional to the amount of chlorine present, it is essential that equal amounts of ortho-tolidine and chlorine by weight be present. If more ortho-tolidine than the 1 : 1 ratio is present some of the holoquinone will be formed. If less ortho-tolidine than the 1 : 1 ratio is present, the red chlorine-substituted holoquinone, extremely stable in hydrochloric acid, will be formed, leaving some free chlorine in solution. When this occurs the depth of the color will be proportional to the amount of ortho-tolidine present, provided that enough acid is present to keep it from precipitating. Under such circumstances the red color becomes a quantitative method for determining ortho-tolidine rather than chlorine, a fact that has been proven spectrophotometrically. For the red color to be a quantitative measure of chlorine, it is essential that the analyst know exactly how much chlorine is present before the test is made. Because of this, the red color becomes valueless as a method for determining unknown chlorine residuals.

Equal Volume Method

Since it is obvious that the holoquinones of ortho-tolidine must be formed to give a true quantitative measure of the chlorine present and that the red color must be avoided, the present *Standard Methods* techniques must be modified in order to determine high chlorine residuals. Two modifications of these procedures can be made in order to insure the proper ratio between ortho-tolidine and chlorine. One increases the amount of ortho-tolidine used and the other decreases the amount of sample used.

In the method where the amount of ortho-tolidine is increased, known as the "Equal Volume Method," chlorine

residuals up to 250 ppm. can be determined. To do this successfully, the 3:1 ortho-tolidine-chlorine ratio (by weight) must be satisfied and the pH must be maintained at approximately 0.5. The addition of the usual amounts of ortho-tolidine to 100 ml. of a 250-ppm. chlorine water would not meet these conditions, due to an insufficiency of ortho-tolidine and to a lack of acid. A 100-ml. volume of 250-ppm. (25-mg.) chlorine water would require the addition of 1 ml. ortho-tolidine solution containing 75 g. per liter. Such concentrations of ortho-tolidine in hydrochloric acid are impossible. This difficulty and that of pH can be overcome by adding the chlorine water to an equal volume of a modified ortho-tolidine solution containing 1 g. of ortho-tolidine and 50 ml. concentrated hydrochloric acid per liter.

This Equal Volume Method is demonstrated by adding equal volumes of 10-, 25-, 50-, 100-, 150- and 200-ppm. chlorine waters to a series of similar volumes of the modified ortho-tolidine solution prescribed above. It is to be noted that the color of the 10-ppm. sample is yellow and that this color becomes more concentrated with each succeeding chlorine residual until it eventually becomes brown.

If it had been possible to use a lesser volume of ortho-tolidine and thereby to have prevented the final color from being diluted to the extent shown, the holoquinone color of all the residuals would have been even more intense, so much so that the highest chlorine residuals would have been black.

It has been stated that the final pH of the holoquinone color of the high chlorine residuals should be very close to 0.5. This is essential for reproducing the same color for any chlorine residual in the neighborhood of 250 ppm. Because of the volume of ortho-tolidine used in the method, this pH is easy to obtain. As the chlorine residual decreases, the colors for any given chlorine residual can be duplicated repeatedly over an increasing pH range. For instance, when a residual of 10 ppm. chlorine is reached, the color remains identical over a pH range of from 0.5 to 1.3. For chlorine residuals of 1.0 ppm. or less, the pH range in which the same color for a given chlorine residual can be formed is from 0.5 to 1.8.

Although the Equal Volume Method has the advantage of producing specific colors for the chlorine residuals shown, it has relatively little value due to the difficulty of distinguishing color variations in small increments of chlorine concentrations.

Drop Dilution Method

In the method where the amount of sample used is decreased, known as the "Drop Dilution Method," residuals can be determined up to 300 ppm. or 2000 ppm., depending upon whether the sample is added to 15 ml. or 100 ml. diluting water containing the ortho-tolidine. To do this successfully the 3:1 ortho-tolidine-chlorine ratio (by weight) must be satisfied, the proper pH maintained and errors involved in dilution brought to a minimum. In this procedure, the proper ratio of ortho-tolidine to chlorine is always maintained by adding at most only enough chlorine water to give a residual reading of 1.0 ppm. If the minimum addition of one drop produces a color greater than the 1.0 ppm. limit, other methods for determining chlorine residuals should be used. The proper pH is maintained by diluting at least 0.5 ml. ortho-tolidine (1.0 g.

ortho-tolidine and 150 ml. concentrated hydrochloric acid in 1 liter) to exactly 15 ml., or 5.0 ml. ortho-tolidine to exactly 100 ml., with chlorine-free distilled water. Excessive dilution errors can be avoided by filling the cell with dilution water exactly to the mark, as noted above, followed by the addition of chlorine water from a dropper, calibrated to deliver 20 drops per ml. By this procedure the chlorine has a chance to react immediately with the ortho-tolidine present to form the proper color concentration rather than to react with other chlorine-consuming substances that may be present.

As finally devised, the test is performed by diluting at least 0.5 ml. ortho-tolidine solution (1.0 g. ortho-tolidine and 150 ml. concentrated hydrochloric acid per liter), to exactly 15 ml., or 5.0 ml. of the same ortho-tolidine solution to 100 ml., with chlorine-free distilled water. By means of the calibrated dropper, then, one or more drops of the water under test are added, the water and ortho-tolidine mixed, and the developed color immediately compared with the permanent chlorine standard of 1.0 ppm. or less. The observed residual is then multiplied by the dilution factor for the cell volume and number of drops used.

In calculating the value of the unknown high chlorine residual the following formulas can be applied:

If the 100-ml. permanent chlorine standards are used:

$$\frac{2000 \times \text{ppm. Cl matched}}{\text{No. of drops unknown}} = \text{Unknown chlorine residual}$$

If the 15-ml. cells in a chlorine comparator are used:

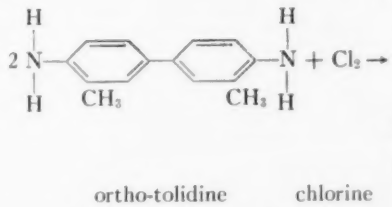
$$\frac{300 \times \text{ppm. Cl matched}}{\text{No. of drops unknown}} = \text{Unknown chlorine residual}$$

In demonstrating the Drop Dilution Method as described above, it will be noted that, as successive drops of water of high chlorine residual (e.g., 100 ppm. or more) are added to the diluting water containing ortho-tolidine, a series of holoquinone colors of increasing depth are obtained. Since the colors develop instantly after each drop, readings can be made and recorded immediately after each addition. When the proper dilution factors are applied, accurate and check values for the chlorine can be obtained.

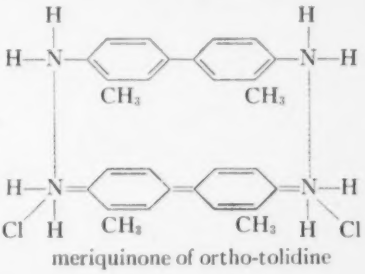
The acid strength used in this test is greater than that prescribed in *Standard Methods* for chlorine residuals up to 1.0 ppm. It is sufficient to take care of all conditions ordinarily encountered in practice. If a lesser volume of ortho-tolidine, or a greater volume of dilution water, be used than that prescribed, it is possible to obtain a color with a green hue—one that cannot easily be matched with permanent chlorine standards. This is a sign that the directions have not been followed and that pH has not been depressed to 1.8 or less.

The variance in color, because of pH changes resulting from excessive dilution of the ortho-tolidine, can be demonstrated by comparing two identical chlorine residuals, e.g., 0.5 ppm., one treated with sufficient ortho-tolidine to give the proper pH of 1.8 and the other with so little ortho-tolidine that the pH will not have been lowered to this value. In the first sample the true yellow holoquinone color is formed, while in the second the color is so green by comparison that it cannot be exactly matched with the permanent chlorine standards. When attempts are made to obtain a reading, the results will be low due to the incomplete development of the holoquinone color.

That ortho-tolidine and chlorine may produce colors other than the yellows and cherry reds is not in the least unexpected, for limitations on the pH, as well as the ortho-tolidine, for proper holoquinone formation, have previously been mentioned in this paper. When the pH for chlorine residuals exceeds the optimum ranges given in the discussion of the Equal Volume Method, off-shade colors are developed due to the formation of meriquinones (9). The word meriquinone immediately suggests the type of reaction involved, for quinone means that the ortho-tolidine is converted to the quinoid form and "meri," from the Greek word *meros* (7) for partly, means that the ortho-tolidine is partially oxidized to the quinoid form. The reaction representing 50-per cent oxidation of ortho-tolidine to the full quinoid form (the holoquinone) is:



ortho-tolidine chlorine



meriquinone of ortho-tolidine

This reaction shows that 2 mols of ortho-tolidine or six gravimetric units, react with 1 mol of chlorine, or one gravimetric unit. Compared with the holoquinone reaction it can be seen that the meriquinone formula represents partial oxidation (50 per cent) of ortho-tolidine to the holoquinone form.

The meriquinones, yellow to blue in color, or any color that can be imagined by mixing the two colors in varying proportions, are formed when the pH exceeds the optimum for quantitative holoquinone formation and the ortho-tolidine-chlorine ratios exceeds 3:1. This color range can be demonstrated by adding ortho-tolidine dihydrochloride solution, drop by drop, to chlorine water of a pH value greater than 1.8. While it has often been reported in the literature that the colors are pH indicators between pH 2.0 and 6.0, it is to be noted that the colors are also dependent upon the amount of ortho-tolidine present.

As the first few drops of ortho-tolidine are added, the quantity is insufficient to give the minimum ortho-tolidine-chlorine ratio (3:1) required to produce the characteristic meriquinones. The colors in this range turn rust, orange or red, with increasing amounts of chlorine. These colors must not be confused with the yellow holoquinone of ortho-tolidine and its red chlorine-substituted derivative used for quantitative purposes. This confusion may result because the colors formed at these higher pH values are extremely unstable, are never fully developed and exist only because an excess of chlorine above that required for regular holoquinone formation happens to be present. These colors have value only as a qualitative method of indicating the presence of chlorine.

As the gravimetric ratio of ortho-tolidine to chlorine proceeds upward from 3:1 to 6:1 the colors vary from

the yellow holoquinone (100 per cent oxidation) through several shades of beautiful green-yellow combinations to a green (where the ortho-tolidine is only 50 per cent oxidized to the holoquinone, as represented by the equation given). These colors are mixtures of the blue meriquinone and the yellow holoquinone, with the latter predominating. As the gravimetric ratio of ortho-tolidine to chlorine proceeds further upward from 6:1 to ∞:1, the colors vary from the green meriquinone through several shades of blue-green and green-blue to a decided blue, where oxidation of ortho-tolidine approaches zero. These colors are mixtures of the yellow holoquine and blue meriquinone, with the latter predominating.

The meriquinones cannot be considered for use in the quantitative determination of high chlorine residuals, due to their instability, their change in color with each change in pH and their dependence on the ortho-tolidine-chlorine ratio. All of these are conditions almost impossible to control.

Summary

This discussion emphasizes: (1) that it is a fallacy to assume that the cherry red color produced with ortho-tolidine at high residuals is a reliable indication of the amount of chlorine present; and (2) the holoquinone of ortho-tolidine produced at low pH values is the only color suitable for the quantitative colorimetric estimation of chlorine residuals of any magnitude, using ortho-tolidine.

Since *Standard Methods* procedures make use of the holoquinones of ortho-tolidine, these methods can be modified to make them applicable for the determination of high chlorine residuals. These modifications are known as the Equal Volume and Drop Dilution Methods. The Drop Dilution Method is particularly valuable for use in emergency water main sterilization, due to its utilization of existing standards and equipment.

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Water Sanitation With Silver

By Alexander Goetz

THE problem of water sanitation by silver is so involved a subject that within the limited space of a short paper it is only possible to discuss some of the fundamental questions—in particular those characteristic of the action and application of silver for this purpose. The subject divides itself into three different types of problems: (1) the nature of the reaction between the living protein and various forms of silver; (2) the various methods by which silver can be applied to water as a germicide; (3) the type of substances and reactions which interfere with germicidal silver.

1. Nature of Reaction

The fact that heavy metals such as mercury, lead, gold, silver and copper attack living matter in general and protozoic life in particular was observed at a very early date; in fact, this knowledge antecedes by more than 2000 years the birth of bacteriology. It is also a fact that silver was singled out from the group of heavy metals quite early, as it is the least toxic to higher forms of life and as no evidence has been produced so far that it is harmful if applied in small concentrations.

In general, it can be said that the desirability of a disinfectant depends upon the ratio of toxic concentration to germicidal concentration. Expressed in this term, silver in certain forms is one of the most desirable disinfectants. To determine the germicidal concentration of silver, however, some sort of quantitative knowledge about the nature of the reaction between silver and cell proteins is necessary.

Under the relatively simple conditions of germicidity prevailing in water, which in most cases can be treated as a highly diluted bacterial nutrient, the following statement is approximately correct: Silver is only germicidal if it is brought in contact with the surface of a cell when the silver atom is in an "excited" * or in an ionized state. Although it appears impossible to produce direct experimental evidence, it is safe to assume that the neutral silver

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* The term is used in the physical sense of excitation, which characterizes any state in which the outer electrons of the atom are in a state different from that of minimum free energy. There are many "excitation states" possible; in the extreme state, one or more electrons are completely removed from the atom, thus resulting in "ionization." The possibility of a chemical reaction with another atom or molecule is considerably increased in the excited state.

atom is as perfectly harmless as silver compounds which do not dissociate, e.g., colloidal suspensions of Ag_2S, etc. From this angle, it can be understood that really clean or highly tarnished (i.e., coated with Ag_2S) silver surfaces are entirely neutral, whereas chemically unclean (i.e. slightly oxidized or halogenized) surfaces of metallic silver show germicidal action to an astonishing degree. This situation presents, at the same time, an answer to the often-asked question whether tableware made of silver or silver plated is germicidal: since the germicidity depends on the chemical nature of the molecular surface layers contacting the micro-organism no germicidal action can be expected under normal conditions. In general, silver surfaces, when freshly prepared (by cleaning or abrasion), are somewhat active, but lose the germicidal state fairly soon, and, although a certain small germicidal action may be retained for quite a while, most of the germicidal capacity disappears after an hour or even less.

Extended experiments concerning the nature of the reaction between the silver and the protein of a living cell give this general situation: The surface of the cell must come in direct contact with an "excited" silver atom or silver ion; the silver ions are absorbed by the cell surface subsequently and form silver-proteinates which denature the protein constituents of the cell to such an extent as to cause the death of the cell. This mechanism is of practical importance, inasmuch as the silver once incorporated into a cell is not given off again and is thus not available to other cells.

Studies on *Sacchs. cerevisiae* (yeast) have shown another interesting relationship: The quantity of silver necessary to *kill* a cell is only an extremely small fraction of the silver-binding capacity of the cell. It has been found that, for such yeast cells, the absorptive capacity of one cell is fairly accurately 10^9 silver ions, whereas the number of ions necessary to kill the cell can vary from 10^4 down to a very small figure. This finding is important not only from a purely theoretical, but also from a practical, point of view. Silver being an expensive material, one wishes to use the lowest possible concentration for germicidal purposes; hence the amount of silver spent on the organisms should if possible, be restricted to the lethal quantity and not extended to the quantity which the cells can absorb, since the ratio of the two concentrations is of the order of 10^5–10^6. It is furthermore important because of the remarkable absorptive capacity, which permits one cell to act as a very efficient shield for other cells, thereby making it very necessary to produce a uniform concentration of silver throughout the volume of water to increase the probability that in every volume element a lethal amount of silver will be available to each organism.

The germicidal effect on the microorganism produced by silver can vary very largely for the same type of organism (water-borne pathogen) between almost instantaneous destruction and prolonged bacteriostasis, depending, aside from the purely bacteriological and chemical conditions, upon the manner in which the silver is applied.

From the viewpoint of water sanitation, it is interesting to note that *Esch. coli* acts, for silver, as a reliable bacteriological indicator for the destruction of water-borne pathogens.

The silver concentrations indicated as necessary for disinfection vary largely in the voluminous literature on

the subject of oligodynamic action; this variation seems to be caused chiefly by the varying efficiency of the silver application. Sufficient germicidity has been reported for silver concentrations of 0.02 ppm. up to 1 ppm. Similar to chlorine, the required concentrations depend greatly on the chemical constituents of a particular water supply and upon the concentration of interfering substances or other conditions. It is thus nearly impossible to make general statements as to the concentration necessary. A particular relation may illustrate this point:

If, according to the above statements, 10^4 Ag ions are lethal to a yeast cell, a liter of water with a concentration of such cells of 5×10^6/ml. would require 10^{13} silver ions. As one γ (10^{-6} g.) of silver contains 5×10^{15} silver ions, only 10^{-2} γ or only 0.00001 ppm. silver should be necessary to kill the entire yeast population under ideal conditions. Effects of this order of magnitude have been observed under laboratory conditions and have given support to the term "oligodynamic action" (from Greek *oligos* = few, *dynamis* = force) as being descriptive of the effect of an almost untraceable amount of the metal.

These ideal conditions of ion availability to each single cell are practically never fulfilled in view of the absorptive capacity of a cell for a number of ions a million times larger than the lethal quantity. According to the above, the quantity necessary for the "saturation" of the cell is at least 10^5 times larger in the case of yeasts and would thus amount to 1 ppm. silver, thus representing the upper concentration limit. Under most practical conditions, however, it has been found that a silver concentration between 0.2 and 0.6 ppm. is sufficient, even in heavily contaminated water. Although detailed quantitative studies are available only in the case of *Sacchs. cerevisiae*, it appears that analogous conditions hold true, not only for the usual waterborne pathogens, but also for yeasts in general, molds and fungi. It is also worthy of note that reactions of this type depend only very little on the hydrogen ion concentration of the water.

2. Application as Germicide

To apply the required quantities of silver in the most efficient form, the problem of its introduction into the water supply to be disinfected is of utmost importance. The methods available range from a simple addition of a water-soluble silver salt to the rather elaborate physico-chemical methods. In view of the brief outline of the limiting conditions given above, it is quite obvious that the addition of minute quantities of silver salts is unfeasible for various reasons: First, one has to avoid the occurrence of local high ion concentrations which are a necessary consequence of the introduction of small quantities of a soluble salt, e.g., $AgNO_3$, to large volumes of water. Second, all silver salts are photochemically unstable, i.e., they are reduced, under the influence of light, chiefly to colloidal silver, which is one of the less efficient germicidal forms of silver as far as the ratio between quantity of silver used and germicidity obtained in water is concerned. Finally, a number of purely practical reasons render this type of application unfeasible.

Two of the first solutions of the problem of an economic and adequate dispersion of silver ions in relatively large quantities of water were developed about twenty years ago in Europe (Germany and France) by Krause and Matzka and were known commercially

as the "Katadyn" and the "Matzka" processes. Both processes use an electrolytic method, but vary between themselves considerably in practical detail. They act on the following principle: The water is passed between two metal surfaces, of which one acts as anode, the other as cathode, the water to be disinfected acting as electrolyte. The anode is metallic silver. In the "Katadyn" process an external electromotive force of a few volts (d-c.) is used between two silver electrodes, the polarity between which is alternated to avoid the cataphoretic contamination of the anode by the organo-colloids in the water. In the "Matzka" process the electromotive force is produced within the cell thermoelectrically; thus the cathode consists of a metal with a large thermoelectric voltage with reference to silver, e.g., aluminum. The heat necessary for producing the voltage is applied externally or by heating the water above the normal temperature. Both processes succeed in dispersing silver ions into the flowing water, because all natural water carries a sufficient quantity of hydrolyzed mineral components to act as a satisfactory electrolyte. As the voltage between the electrodes is kept below the potential necessary for the dissociation of water (i.e., for the development of oxygen and hydrogen at the electrodes) the anions (probably chiefly carbonate) will react at the silver anode and thus produce silver ions which in turn migrate toward the cathode. Thus the flow of water carries a considerable concentration of ionic silver away from the electrodes, especially as care is taken that the cathodic deposit of metallic silver is kept at a minimum. If the electrodes are arranged in such a way that the water, while passing them, is divided into many channels, the process can be made very efficient, but it is also obvious that the anion constituents of the particular water supply used are of major influence and control the initial reaction at the anode. Gradually the silver supply at the anode is exhausted and has to be replaced. By controlling the flow rate between the electrodes and the current density at the electrodes, one can control the resulting silver concentration in the water with the use of Faraday's Law of electrochemical equivalents.

Aside from the electrolytically produced dispersion of silver, there are numerous other methods possible, the feasibility of which depends on the particular conditions or the specific purpose. For relatively small quantities of water, the use of silver filters was attempted at a relatively early date. The methods followed in these attempts some of which have been very successful indeed, are so varied that it is impossible to describe them all in detail. Common to all is the effort to subdivide the flow of water into small stream elements in order to expose as much of the "germicidally active" surface as possible to the flow of water and thus to decrease the distance between ion source and micro-organism. This was done to avoid the necessity of long-range ion diffusion, for any diffusion process is not only slow, but increases the probability that the silver ion on its way to the cell will be captured or incapacitated either by a shielding micro-organism or by the chemical reaction with an inhibitory constituent of the water. The voluminous international patent literature on the subject of silver disinfection deals almost exclusively with devices to overcome this particular problem in a more or less feasible manner. The larger the flow rate of the water and the volume of the

water to be treated, the more involved is the practical solution of this problem. It appears to be the chief difference between the application of electronegative disinfectants like chlorine and electropositive disinfectants like silver.

3. Interfering Substances and Reactions

Next to the nature of the germicidal reaction and its practical application ranks the nature of the chemical interference with organic or inorganic constituents of the water supply. One type of interference common to all disinfectants is that of coarse suspended matter which is capable of shielding micro-organisms against chemical reaction with the disinfectant. As this type of suspended matter is easily removed by sedimentation or simple filtration processes, the serious problems rest with waters relatively free from turbidity, where silver can be absorbed by protein-like substances regardless of whether they belong to a pathogenic organism or not. It is thus necessary that the filtration be rather efficient in removing the major portion of organocolloids in order to avoid the necessity of excessive silver concentrations.

The chemical interference of the inorganic type is a particularly interesting problem in the case of silver. It is very fortunate that practically all silver compounds resulting from the radicals occurring in water supplies (e.g., sulfate, chloride, carbonate, nitrate, phosphate) have solubility products considerably above those of the silver-protein combinations. The only exceptions are sulfide, cyanide and, probably, iodide, of which, for water supplies, only the first can be important. Thus the anions in water supplies do not interfere at all; e.g., even for the chlorides, the solubility limit of AgCl lies about three times above the maximum necessary germicidal concentration of silver. The great affinity of silver for sulfur, whether it occurs free (H_2S) or organically bound (e.g., the mercaptans) has a tendency to incapacitate the germicidal actions of silver if the resulting silver-sulfur compound is not dissociated. Thus, silver sulfide as such is not germicidal; its formation in the presence of sulfur and the resulting interference with "active" silver, however, appears easily preventable for the sulfur concentration range occurring in normal water supplies.

The lack of interference by cations normally occurring in water (Ca, Mg, Na, K, Fe, Si) presents a similarly fortunate property of silver. As far as the concentration of hydrogen ions is concerned, it has already been mentioned that the germicidal action of silver does not, in contradistinction to chlorine, depend on pH, but reaches far into the alkaline region. It is probably characteristic for a disinfectant active as cation that the presence of hydrogen ions is not important for the protein reaction. Contrary to the hydrogen, ammonia is a source of possible interference with silver, most likely due to the tendency of the latter to form complex ions such as $Ag(NH_3)_2$ which seem to lack germicidal qualities. It appears, however, that the incapacitation of silver by complex formation can be prevented in most cases by the maintenance of a sufficient partial pressure of oxygen in the water.

Conclusions

Hence it is apparent that the problem of using silver as a water disinfectant involves a number of novel tasks which deviate from the traditional problems of chemical water dis-

infection, due to the peculiar nature of the protein affliction and of the interfering reactions. In fact, it appears at first sight paradoxical to employ silver for the same purpose as its chemical opposite, chlorine.

Silver presents numerous advantages over any other disinfectant of electronegative nature which justify a thorough investigation of its applicability in water sanitation. First of all, it has in certain forms of application the least toxic index known, it is not an irritant and it does not interfere with the taste of the water. The concentration at which silver can be discovered faintly by taste is about twenty times higher than a fully adequate germicidal concentration. Silver has, furthermore, the advantage of absence of a vapor pressure; thus prolonged storage of silver-sterilized water will not result in the evaporation of the disinfectant and subsequent disappearance of the retained germicidal qualities of the water. One can easily demonstrate that water retains germicidal qualities for more than a month, in spite of daily re-infection.

The objection which is probably chiefly responsible for the delay in practical developments can be attributed to the fact that silver is a "precious" metal; and the comparison between the price of a pound each of silver and of chlorine, even at the low prevalent price of silver on the world market, is an obvious demonstration. The quantities of silver involved in water sterilization, if efficiently applied, however, are extremely small, with the result that a non-recoverable expenditure of silver should not exceed five dollars per million gallons.

Ozone Treatment of Water

By Victor Hann

NATURE has been purifying water for a million years by the process of oxidation—and has consistently produced a good water. But Nature takes too long; man impatiently demands better service. There are more rapid oxidizing agents than air and bacteria and it is logical that man should try to accelerate the natural process by using them. He found he could speed up the oxidation process tremendously by the use of chlorine (break-point chlorination); yet there was still another oxidant, much more potent than these, which he found he could use. That substance is ozone—the most powerful oxidizing agent available for water treatment.

Ozone is a faintly blue, pungent smelling gas. It is an allotropic form of oxygen in which three atoms of oxygen, instead of only two atoms as in the case of ordinary oxygen, are combined to form a molecule. This third atom is constantly attempting to break its bond with the other two and will combine at once with any oxidizable substance. Since ozone contains nothing but oxygen, it is a very special kind of oxidizing agent. When chlorine and potassium permanganate act as oxidants they add elements, other than oxygen, to the water. Often these elements are undesirable.

Although ozone can be formed in a variety of ways, the only cheap practical method is by the action of an electric discharge upon air or oxygen. If air is passed between electrodes, across which a corona discharge is taking place, a small percentage of the oxygen in the air is converted into ozone.

Ozone is very unstable; it decomposes in a relatively short time. This, together with the fact that a small concentration of the gas is contained in a large body of air, makes it unfeasible to store it or ship it in containers. Therefore, ozone is generated at the point of use. Air is cleaned, dried and passed through an ozone generator. The resulting mixture of ozone and air is bubbled through a chamber containing the water to be treated.

Early Ozone Treatment Plants

The early investigators of ozone treatment were primarily interested in its bactericidal properties. In 1840, Schönbein experimented with ozone for treating water at Metz, Germany. In 1886, DeMeritens investigated ozone as a germicide for the sterilization of water. He showed that ozonized air would disinfect a polluted water provided intimate contact between water

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and air was maintained. A few years later Frölich (1), reinvestigated the subject and erected a semi-commercial plant at Martinikenfeld, Germany. The treatment and bacteriological results were studied by Ohmüller and Prall at the request of the German Government. Their report (2) was favorable and led to full scale municipal installations at Weisbaden and Paderborn (1896).

Otto is said to have erected an ozone treatment plant in 1890. At about the same time a plant was installed at Oudshoorn, Holland, which was investigated by the Belgian Government and by the City of Paris (3–5), leading to the adoption of ozone treatment at the St. Maur plant in Paris. Ozone plants were installed at Lille in 1898 and Nice in 1904.

By the outbreak of the present war, in France alone more than a hundred municipalities were treating a total of 264 mgd. with ozone. There were ozone plants in Leningrad, Budapest, Manchester, Ghent, Madrid, Florence, Weisbaden, Groningen and many other European cities (6, 7). A new plant at Paris had a capacity of 79 mgd.

In the United States adoption of ozone has not been rapid. In 1927 a plant was installed at Delhi, N.Y., but was damaged by flood and abandoned in 1935. In 1930 a plant was completed at Long Beach, Ind. This was followed by another at Hobart, Ind. in 1932 (8). In 1940 plants were installed at Denver, Pa., and Whiting, Ind. (9–11).

There has been an important difference between the European and American approach in the use of ozone. In Europe, the primary objective has been bactericidal—the production of a safe water using ozone as a germicide. In America, on the other hand, the bacteriological properties of ozone have been looked upon as secondary to the oxidizing power. Removal of color, taste and odor by oxidation has been the primary objective.

Disinfection

In general, if disinfection were the sole objective, ozone would be a more expensive treatment than chlorine. Ozone is a good germicide (1–4, 8–11). Of course, proper precautions must be taken in applying the ozone to the water to insure disinfection:

1. *The water should be low in turbidity.* Ozone, no more than chlorine, can destroy bacteria if they are sheathed in suspended matter.

2. *The "ozone demand" must be satisfied.* Enough ozone must be added to oxidize organic matter and leave a residual of free ozone in the water.

3. *There must be a residual of free ozone in the water for a definite time interval.*

The Scientific Commission for the City of Paris has recommended the following time intervals for standard practice:

1 min. when water temperature exceeds 20°C.
5 min. when water temperature is 10°–20°C.
10 min. when water temperature is below 10°C.

4. *For economy, the ozone must be applied efficiently.* This requires an intimate mixing of ozone and water in a deep tank.

If these conditions are fulfilled, disinfection is no problem. For example, in Philadelphia, in a 1-mgd. demonstration plant, which was operated continuously from April 1941 to April 1942, 312 samples of filtered ozonized water were examined by standard

methods. In every case, the sample passed U.S. Public Health Service Drinking Water Standards even though the volume of sample tested was 100 ml.

An interesting sidelight of these tests is the effect of ozone on non-confirming gas formers. The source of the water under treatment was the Schuylkill River. Bacteriological tests showed that the water contained an organism, resistant to chlorine, that formed gas from lactose (12). Confirmatory tests for *Esch. coli* were negative. Although the sanitary significance of such gas formers is debatable, the trend is to do everything possible to eliminate them. Table 1 shows the effect of chlorine, ozone and ozone plus chlorine upon the frequency of appearance of non-confirmable gas formers. With chlorine treatment, 40 per cent of all tubes inoculated showed non-confirmable gas; with ozone, 28 per cent; and with both ozone and chlorine, only 19 per cent. In other words, a combination ozone-chlorine treatment reduced the frequency of occurrence of non-confirming gas formers by more than 50 per cent over chlorine alone.

TABLE 1

Effect of Chlorine and Ozone Treatment on Non-Confirmable Gas Formers, Lower Roxborough, Philadelphia

Treatment	Total No. Tubes Planted	No. Tubes Showing Non-Confirmable Gas	Percentage Tubes Showing Non-Confirmable Gas	Chlorine		Ozone	
				Residual	Contact Time	Residual	Contact Time
			%	*ppm., avg.*	*min., avg.*	*ppm., avg.*	*min., avg.*
City Tap (Filtered and Chlorinated)	2185	870	40	0.13	(Several hr.)	—	—
Filtered and Ozonated	2185	620	28	—	—	0.13	6.5
Filtered, Ozonated and Chlorinated	1470	281	19	0.09	30	0.13	6.5

If ozone is applied to a turbid water, although complete sterilization cannot be obtained, a reduction of 95 per cent or more in the number of bacteria is to be expected.

Color Removal

In natural waters color is generally caused by soluble vegetable dyes leached from decaying vegetation. Sometimes organic matter combines with iron in the water to form colored compounds; in such cases both color and iron are extremely difficult to remove.

Oxidation has frequently been used as a means of color removal. Superchlorination and application of potassium permanganate have been methods of oxidation employed. McCrea (15) reports successful treatment with potassium permanganate of a water of extremely high color containing organic iron compounds.

At Hobart, Ind. (8) a water with high vegetable color is treated with ozone after filtration. The filtered water color is about 25 ppm.; ozone treatment reduces this to 2 ppm. or less. Ozone dosage is estimated to be 2–3 ppm.

A typical data sheet for color removal is presented in Fig. 1. The water source was the Fox River in Wisconsin draining Lake Winnebago in which decaying vegetable matter produces a high color. Coagulation and filtration reduced the color to 28 ppm. The effect of increasing ozone dosages upon the remaining color is shown in the figure.

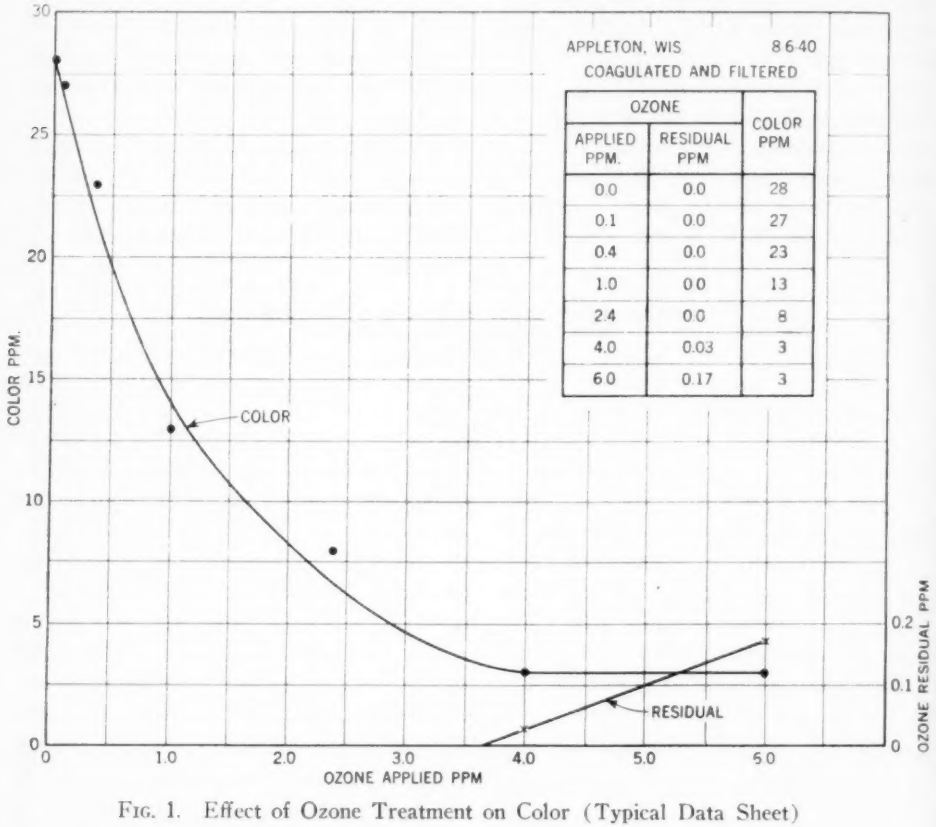

FIG. 1. Effect of Ozone Treatment on Color (Typical Data Sheet)

At Miami, Fla., an ozone pilot plant has been in operation for several months. Well water with a high color is softened with lime, normally reducing the color to 20–30 ppm. Ozone is applied to the softened water. A dose of 2–3 ppm. reduces the color about 50 per cent; more ozone will reduce the color further. It appears to be most economical to reduce the color to 20–25 with lime and then treat with ozone to produce a final color of 10–12.

Taste and Odor Removal

Talking about taste and odor removal is always a ticklish subject. Evaluation of taste and odor quality is very difficult because so much depends upon personal preference and individual judgment.

Undoubtedly, the threshold odor number is the best *quantitative* measure of odor (and taste) available; but to the consumer, the *quality* of the odor or taste is certainly as important as the intensity. If the manufacturers of

Scotch whisky were to limit the threshold odor number of this product to 10 or less they would soon go out of business. Aroma in beverages is acceptable, usually essential, but it must be a *pleasing* aroma. This holds true for water. We strive for a neutral product—no taste, no odor—but this does not mean that a water with a pleasing taste might not be more acceptable to Mr. John Doe.

Phenols, hydrogen sulfide, sulfur compounds, hydrocarbons, tarry compounds, sewage products, sugar beet wastes and decaying vegetation can usually be oxidized to tasteless, odorless products. Some industrial wastes, essential oils, organic matter, algae and micro-organisms yield, upon oxidation, stable compounds which may replace the original obnoxious tastes and odors with an agreeable one. Most "naturally" purified waters have a characteristic faintly sweet odor and taste.

Since most natural waters contain a combination of odor-producing compounds, oxidation of such waters normally has a dual effect: (1) some odor-producing substances are oxidized to odorless, tasteless compounds; (2) other odor-producing substances are changed in character, usually to a faint sweetish odor or taste. As a result the intensity of odor is reduced and the character changed. The exact result depends upon the constituents making up the original water.

At Long Beach, Hobart and Whiting, Ind., and Denver, Pa., ozone treatment has been responsible for exceptional improvements in palatability. At Hobart a vegetable odor, caused by decaying vegetation, was completely removed. At Long Beach, Lake Michigan water, without coagulation or filtration, is treated with ozone to improve taste and odor. At Denver, spring runoffs and high algae concentrations created obnoxious odors difficult to remove. At Whiting, a combination of industrial and refinery wastes has created a water which was impossible to treat by any method until ozone was tried. Odor and taste intensities were greatly reduced and the odor character changed to a pleasant one, highly satisfactory to the consumers.

A typical data sheet for ozone treatment of a notoriously bad water is presented in Fig. 2. The source of the water is the Saginaw River heavily polluted with wastes from sugar beet factories and a large chemical plant at Midland, Mich., producing more than 400 different chemical products. The threshold odor number of the treated city water at Saginaw sometimes reaches 2000, seldom falls below 100. The character of the odor is most unpleasant ranging from phenolic to urinous. The figure indicates the effect of ozone treatment alone and of ozone followed by carbon filtration. The chart does not, however, indicate the change in *character* of the taste and odor. The original disagreeable taste and odor was removed and a pleasant sweetish odor remained. Increased ozone dosage, or carbon filtration, reduced the intensity of this odor, but it was found that the average consumer actually preferred ozone-treated water with some taste and odor remaining.

Coagulation

In many waters, colloidal organic matter tends to hamper floc formation. Sometimes oxidation of the organic matter will upset colloidal equilibrium and increase coagulation efficiency. At Whiting, Ind., where ozone is used as a preliminary treatment, this pre-oxidation reduced alum usage by 30 per cent.

Iron and Manganese Removal

Soluble iron or manganese compounds or complex iron-organic compounds are often troublesome to remove from water. Oxidation with ozone will precipitate iron as ferric hydroxide and manganese as manganese dioxide. Subsequent coagulation and filtration will remove these precipitates. The advantage of oxidation with ozone is that adjustment of pH is usually unnecessary. For example, a demonstration ozone treatment plant at Philadelphia has been quantitatively removing manganese from Schuylkill River water at a pH of 6.8 to 7.0.

Cost of Ozone Treatment

To generate and apply ozone to a water supply, an air filter, a compressor, drier, ozone generator, mixing tank and necessary inter-connecting piping, controls, etc., are required. The cost of such an installation varies tremendously depending upon pollution conditions, ozone demand, geographical factors and physical characteristics of the plant itself. It is virtually impossible to give any general figures on first cost.

The operating costs for an ozone treatment plant are predominantly power costs. To generate and apply 1 lb. of ozone, 14–16 kwhr. are re-

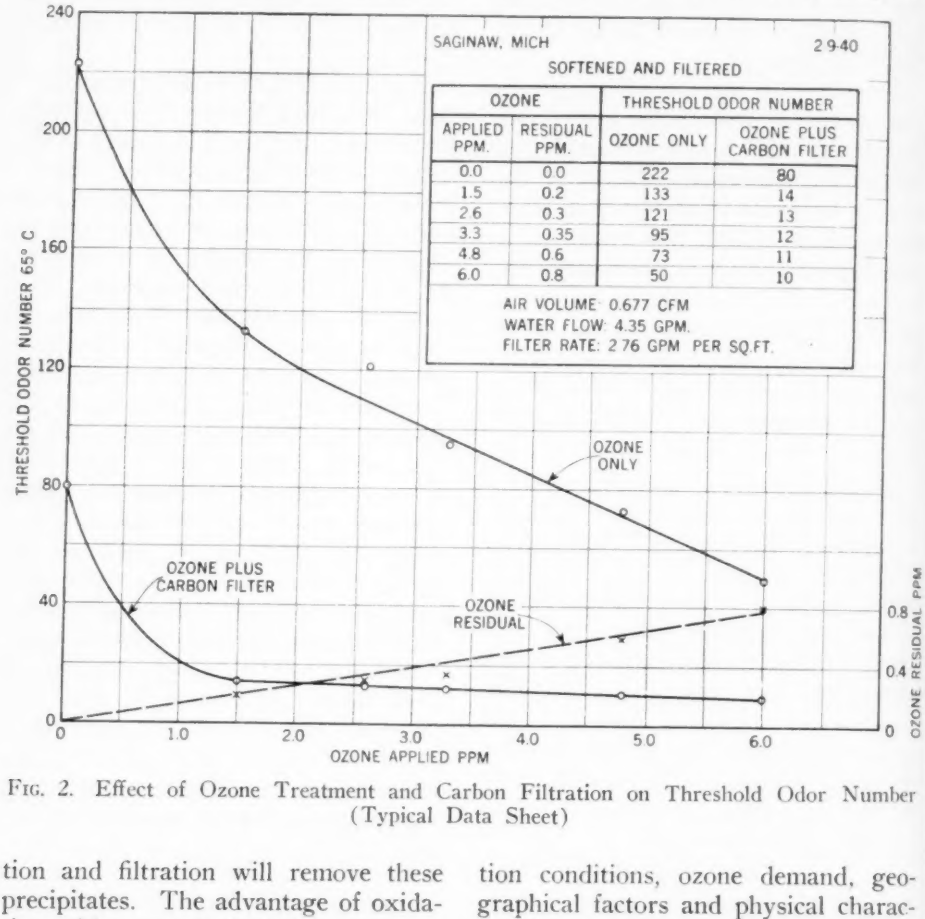

FIG. 2. Effect of Ozone Treatment and Carbon Filtration on Threshold Odor Number (Typical Data Sheet)

quired. Depending upon ozone requirements and power rates, this means the power cost may be less than a dollar per million gallons or may be several dollars per million gallons. No additional personnel should be necessary for operation or maintenance of the ozone equipment.

Control of ozone treatment is simple and foolproof. Ordinarily the ozone residual, as measured by the common ortho-tolidine test, is used. Since over- or underdosage is not particularly harmful (except where disinfection is required) supervision is reduced to a minimum. Ordinarily all equipment is operated electrically from a central control panel.

The Future for Ozone Treatment

In the postwar picture many elements seem to augur a rapid development of ozone treatment. First, there is the trend toward the highest quality of water possible. Second, the cost of ozone equipment should be much lower after the war. Low-cost aluminum, new plastics, improved fabrication methods, cheaper electrical equipment and improved design should reduce ozone generator and auxiliary costs to a fraction of the pre-war figures. Third, expansion of power resources and extension of low-rate power supplies should reduce the operating cost. Improvements in design will reduce power requirements for a pound of ozone to perhaps 10–12 kwhr.

Ozone is not a cure-all. It is, rather, a most useful tool for attacking many water treatment problems. It has advantages over other oxidants in that it adds nothing but oxygen to the water, does not increase hardness or aggressiveness, does no harm if over- or underdosed. It is easily and cheaply applied and will produce a water of excellent quality from a standpoint of appearance, palatability and safety.

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Determination of the Phenols Content of Surface Waters

By R. D. Scott

EXPERIENCE with various chloro-organic tastes has shown that the chlorophenolic type is the most nauseating. Although the steel industry has greatly reduced the percentage of phenols in coke oven wastes, the amount present in the receiving surface waters has increased with the increase in coke production, in consequence of which the problem of avoiding such tastes in certain municipal waters is still important.

The Ohio Department of Health laboratories have made phenol determinations on surface waters for a number of years, during the course of which a procedure has been developed which is believed to be an improvement over the earlier methods.

Preservation of Samples

The recommended procedure of adding sodium hydroxide * was found to be ineffective. Two years ago the author tried several preservatives and selected copper sulfate as being the most satisfactory for the purpose of preventing loss of phenols, presumably through inhibition of bacterial decomposition. The copper sulfate will maintain the initial concentration for about 24 hr. at 25°C. and about 72 hr. at 10°C.

Analytical Details

Indicator: The author considers the Gibbs reagent preferable to the diazotized sulfanilic acid indicator. However, certain modifications in procedure are desirable. The color development with Gibbs' reagent and phenol is not the same as with the cresol isomers. Phenol produces a green-blue color, orthocresol a red-blue or purple, metacresol a definite blue color, while no color compound is formed with paracresol.

Since it is not practicable to compare a green-blue with a purple color it was necessary to use a mixture of phenol and cresols as a standard. After extended trial with various mixtures in comparison with stream samples, it was concluded that a standard containing equal parts of phenol and orthocresol was most suitable. Although it does not provide an identical color match for all samples, since the proportion of the cresols and phenol naturally fluctuates, the simulation is sufficiently close for satisfactory matching.

A revision of a paper presented on May 14, 1942, at the Ohio Section Meeting, Toledo, Ohio, by R. D. Scott, Chief Chemist, State Dept. of Health, Columbus, Ohio.

* *Standard Methods for the Examination of Water and Sewage.* Am. Public Health Assn. & Am. Water Works Assn., New York (8th ed., 1936), p. 245.

The indicator is added as an alcoholic solution instead of as the prescribed aqueous solution, since this deteriorates rapidly; the alcoholic solution, if kept in a refrigerator, retains its sensitivity for at least a week. For the production of clearest colors the amount of indicator added should be limited to about 0.2 mg. per 100 ml. of standard or sample distillate. Concentrations of phenols in excess of 0.05 mg. per 100 ml. produce color of too great intensity to be read with accuracy. If the sample distillate contains more than this amount, an aliquot should be taken. The Gibbs reagent, dibromoquinone chloroimide, as manufactured is not always of satisfactory sensitivity; the yellow or brownish-yellow powder form is found to be more sensitive than the greenish, crystalline form sometimes obtained.

Distillation: Instead of collecting a series of distillates, the author prefers to take a sample volume of 225 ml. and, after neutralizing it with acid, to distill it in an all-glass still to a volume of 200 ml. This provides a reasonably close compensation for the residual phenols in the distillation flask, which amounts to about 10 per cent of the total.

Preparation of Reagents

1. *Standard Phenol and Orthocresol:* Weigh 1 g. of reagent grade phenol crystals into a 1-liter volumetric flask, make up to mark with distilled water, stopper and shake until dissolved and mixed. Weigh 1 g. of orthocresol (Eastman Kodak Co.) crystals into a 1-liter volumetric flask and add 20 ml. of 1*N* sodium hydroxide. When solution of the orthocresol is complete, make up to the mark with distilled water and mix. These stock solutions should be kept under refrigeration. Prepare a solution containing 5 ppm. phenol and 5 ppm. orthocresol, total phenols 10 ppm., by adding 5 ml. of each stock solution to a 1-liter volumetric flask, make up to the mark with distilled water and mix. This solution should be made up fresh each day it is used.

2. *Buffer Solution*:* Place 3.1 g. boric acid, HBO_3, 3.5 g. potassium chloride, KCl, and 32 ml. 1*N* sodium hydroxide, NaOH, in a 1-liter volumetric flask and make up to the mark with distilled water. A 5-ml. volume diluted with 100 ml. distilled water has a pH of 9.4.

3. *Indicator:* Dissolve 0.04 g. dibromoquinone chloroimide (Eastman Kodak Co.) in 10 ml. of 95 per cent ethyl alcohol. Keep under refrigeration. Make up a fresh solution if held longer than one week.

Procedure

Collection of Samples: Add 1.5 g. of copper sulfate crystals to a ½-gal. glass-stoppered bottle and fill with the water to be examined.

Distillation: Place 225 ml. of the supernatant sample in a 500-ml. distillation flask (all glass-joint flask and condenser, Pyrex No. 3360). Add just enough 0.1*N* HCl to neutralize the previously determined methyl orange alkalinity. Substitute 0.2*N* acid if the alkalinity exceeds 250 ppm. Connect to condenser and distill, at a rate of about 5 ml. per min., up to the mark in a 200-ml. flask. Stopper and mix.

Standards: From the 10-ppm. phenols solution prepare a series of stand-

* THERIAULT, E. J. Chemical Aspects of Stream Pollution by Phenols. Ind. Eng. Chem., **21**: 343 (1929).

ards, such as 0, 0.01, 0.02, 0.04, 0.06, 0.08, 0.1, 0.2, 0.3, 0.4 and 0.5 ppm. in 100 ml., in 6-in. matched-set Nessler jars. Make up to mark with re-distilled water.

Determination: To samples of distillate of 100 ml., of 50 ml. diluted to 100 ml. and of 25 ml. or other aliquots diluted to 100 ml. with re-distilled water, and to the standards, add 5 ml. of buffer solution. Add two drops of indicator solution to each Nessler jar, mix at once, let stand overnight and compare sample colors with the standards.

Scalar Diagram for pH of Calcium Carbonate Equilibrium

By A. A. Hirsch

IN DETERMINING the pH of calcium carbonate saturation, of interest mainly in corrosion control, Larson and Buswell (1) presented a method for adjusting the Langelier formula (2) by terms having more physico-chemical foundation than those furnished in the original development. Nevertheless, comparative effects of temperature and salinity by either the Langelier or the Larson-Buswell methods are in close enough agreement except under extreme combinations of temperature and dissolved solids. An advantage of the Larson-Buswell formula is its segregation of the effects of ionic strength and of temperature.

Two devices, based on Langelier's tables, have appeared to facilitate the calculation of pH_s—one a nomogram (3) and the other a special slide rule (4). For most applications these aids should retain their full usefulness as the divergence between the results by the Langelier and the Larson-Buswell corrections are insignificant at ordinary temperatures.

The accompanying scalar diagram is intended to simplify the calculation of pH_s by the more recent corrections. This drawing is merely a system of co-linear scales. In use only a small amount of simple pencil work is needed —this in lieu of the alignment with a straight edge required by a nomograph. These scales also permit directly a visual appreciation of the relative importance of each contributory factor.

Positive terms in the formula are marked off to the right of a central origin, negative terms to the left. The value of pH_s is obtained by adding the algebraic sum of the scale readings to 9.30, as indicated in the directions printed below the diagram. Temperature is given in both common systems. Calcium rulings are provided as the ion and also as calcium carbonate so that the results of a selective soap test are immediately applicable. As pointed out (1) the pH value at the tempera-

A contribution by A. A. Hirsch, Instructor in Water Purif., State Dept. of Education, Baton Rouge, La.

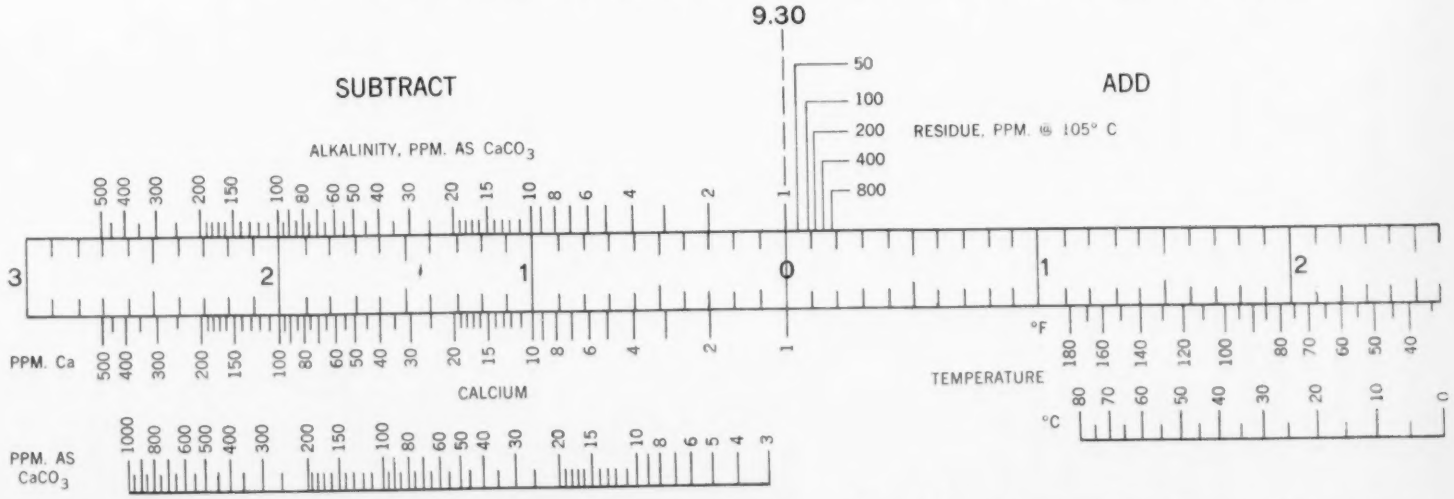
Diagram for pH of Calcium Carbonate Saturation
Langelier Formula; Larson-Buswell Residue-Temperature Adjustments

Diagram for pH of Calcium Carbonate Saturation

Langelier Formula; Larson-Buswell Residue-Temperature Adjustments

$$pH_s = \log \frac{K_s}{K_2} - \log Ca^{++} - \log Alky. + 9.30 + \frac{2.5\sqrt{\mu}}{1 + 5.3\sqrt{\mu} + 5.5\mu}$$

K_s = Activity product constant of $CaCO_3$
K_2 = Activity constant for second dissociation of H_2CO_3
Ca^{++} = Calcium, ppm.
Alky. = Alkalinity, ppm. as $CaCO_3$
μ = Ionic strength = (residue on evaporation, ppm. @ *105°C.* × 0.000025) approx.



DIRECTIONS: To 9.30 add the sum of the scale values opposite the residue and the temperature figures. From this subtract the sum of the scale values corresponding to the calcium and the alkalinity.

EXAMPLE: Given Ca = 10 ppm., Alky. = 50 ppm. as $CaCO_3$, Temperature = 80°F., Residue = 200 ppm.; find pH_s

SOLUTION: $pH_s = 9.30 + (0.11 + 1.96) - (1.00 + 1.71) = 7.66$

SIGNIFICANCE:
- $pH < pH_s$ undersaturated; corrosive tendency
- $pH = pH_s$ stable
- $pH > pH_s$ supersaturated; scale-forming tendency

ture for which pH_s is calculated should be used in determining the corrosion index, i.e., $pH - pH_s$, in order to use the appropriate physico-chemical constants directly. This restriction is tantamount to limiting the pH determination at other than room temperature to the use of electrometric methods, among which the glass electrode, with a temperature compensator in the circuit to preserve the proper electromotive-force-pH relation up to 40–50°C. is the most satisfactory choice.

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Erratum

Tentative Emergency Specifications for Reinforced Concrete Pressure Pipe, in the April 1943 issue:

Page 499, in the box, second paragraph, twelfth line: *for* exhibit no greater rate of breakage, *read* exhibit no greater rate of leakage.

Color Removal With the Accelator

By J. M. Kahn

UNTIL about six years ago, developments in water treatment equipment for the separation of solids followed the line of separately improving the component stages of the conventional three-stage treatment process. This involved quick intimate mixing of the treating chemicals with the water undergoing treatment, slow mixing of the precipitate to promote gathering and coagulation and separation of the solids by permitting them to settle quiescently in large tanks.

In the three-stage process, the initial steps of rapid and intimate mixing of the chemicals causes a degree of subdivision which is opposed to the gathering of the particles into easily separable masses in the final stage of treatment. This condition necessitated further treatment in the second stage and often resulted in poor settling in the third stage.

As early as 1923, it had been found that the recirculation of precipitated solids greatly increased the rate and the completeness of lime-softening reactions. A process was developed whereby sludge from the settling basins was pumped back to the initial mixing chamber for contact with the raw water and treating chemicals. Although a certain degree of improvement was noted, the damage to the precipitated particles of sludge, caused by the pumping, resulted in deflocculation and imposed a greater clarifying load on the equipment. Moreover, the infrequent return of the individual particles prevented any uniform or controlled particle growth.

Development of Accelator

The Accelator * softening process grew out of this sludge-return process, but overcame its disadvantages. The fundamental principle of the process was based upon the controlled recirculation of precipitated solids and the admixture of raw water and treating chemicals under conditions of mixing which prevented particle damage, but fostered the precipitation on the existing sludge particles so as to produce larger, denser and tougher floc particles.

Although the Accelator was developed primarily to provide an adequate sludge contact so as to improve the efficiency of lime-soda softening, the formation of the large dense sludge particles made it possible to separate the treated water from the sludge at rates as high as 3 gpm. per sq.ft., as a consequence of which such installations require an area considerably smaller

A paper presented on November 14, 1942, at the Florida Section Meeting, Miami, by J. M. Kahn, Infilco Inc., Atlanta, Ga.

* Product of Infilco Inc., Chicago.

than that of a three-stage treatment plant of the same capacity.

Application to Clarification and Color Removal

A logical outgrowth of the success achieved by the Accelator softener was the development of a clarifier of the same type. The principle of controlled sludge recirculation proved to be equally effective when aluminum hydroxide or an iron hydroxide was precipitated to form particles for the coagulation and removal of suspended or colloidal particles. The advantages of the Accelator for clarification and color removal may be indicated by a brief consideration of some of the factors involved in the processes.

Whenever precipitation is induced in a clear solution, there is the primary formation of particle nuclei, which in time will grow to form relatively large particles. In many dynamic water treatment systems, however, the nuclei are not given an opportunity for adequate growth; consequently, a large proportion of them may be carried over with the treated water unless exceedingly low rising rates are employed in the settling basins. This nuclei formation occurs in all water treatment reactions, but causes the most trouble in clarification equipment because of the low density and slow settling rate of the floc particles.

The old practice in the designing of water clarification equipment was to consider color as a physical characteristic of the water in question and to make allowance in the design of the plants accordingly. A number of years ago a typical New England type of filter plant in South Carolina proved its inability to reduce color materially, but the addition of a mixing chamber greatly improved results. Engineers made allowances in the design of mixing chambers to permit additional time and to lower the velocity of mixing. The basins were baffled in many ways by the various plant designers, but all designs lacked the quality of being readily adjustable to meet varying requirements caused by differences in the composition of the various waters.

The benefits of proper mixing were demonstrated, however, and experience with baffle mixers soon led to the development of mechanical mixers in many forms. Considerable difference of opinion as to the proper design of these conventional plants still exists, but it is generally believed that the type of mixer which insures an intimacy of contact of the floc particles by a gently rolling-over action is to be preferred. It has also been found desirable to be able to vary the speed of the mixing to compensate for temperature differences in the raw water since such differences seem to have an effect upon the floc density. Generally, separate coagulating chambers are constructed to permit repairs to be made to the mechanical equipment without draining the entire settling basin; consequently, the treatment plant of this type requires a relatively large area and has a disproportionately high cost of installation.

In spite of the low rising rate employed, the floc formed in this type of equipment did not settle completely and it was found necessary, in many cases, to add coagulant aids, such as bleaching clays, sodium silicate, bentonite, etc., to weight the floc and improve settling.

In the Accelator, however, effective solids separation is obtained without the use of any weighting agent as the

formation of new particle nuclei is inhibited by precipitation on the existing sludge particles. This results in improved clarification and color removal.

Reduction of Coagulant Dose

Besides decreasing the costs of clarification plants, the Accelator results in a substantial saving in the cost of treatment. The controlled sludge recirculation results in improved coagulation with minimum dosages.

Although each water presents a somewhat different coagulation problem, it is known that each can be coagulated most effectively at its optimum pH, provided that sufficient coagulant is present to adsorb the suspended and colloidal particles. For instance, in the case of many turbid water supplies, optimum coagulation occurs at a relatively high pH, while clear, highly colored waters generally require treatment at a low pH (as low as 4.0 in some cases).

In cases where the raw water has a high alkalinity and a high color, it is usually necessary to neutralize this excess alkalinity to get down to the optimum pH. In most cases this alkalinity reduction is obtained due to the acidity of the coagulant, but, in some instances, it is possible to reduce the coagulant dosage by partially neutralizing the alkalinity with sulfuric acid. With colored waters of this type, the optimum pH must be approached before effective color removal can be obtained. When the coagulant is used to depress the pH, generally the quantity of floc precipitated is sufficient to adsorb the semicolloidal color particles, thereby resulting in good decolorization. When an excess of coagulant is used to depress the pH, the treatment may prove to be relatively expensive, particularly when the water has a high alkalinity. On the other hand, with waters of relatively low alkalinity, the quantity of coagulant normally required for coagulation may depress the pH below the optimum value, making it necessary to feed some alkali to raise the pH to a point where good coagulation is obtained.

In the Accelator, however, two factors tend to reduce the quantity of coagulant required for maximum color reduction. As the floc particles are recirculated through the reaction zones, their contact with raw water during each passage through the reaction zones results in a more complete utilization of the adsorptive properties of the coagulant. Moreover, the initial coagulant, which is continually being added, tends to precipitate on the surface of the existing particles, thereby presenting a larger surface for adsorption. Consequently, the maximum coagulant efficiency is obtained and the optimum pH of treatment can be achieved to a greater extent with sulfuric acid in the case of highly alkaline waters. In the case of low alkalinity waters, the coagulant dosage and also the alkali dosage for pH correction can be reduced.

In many instances, the hardness of the raw water necessitates treatment with lime or lime and soda ash with the primary objective of reducing hardness. In these cases, color removal is less effective, since the calcium carbonate and magnesium hydroxide sludge particles are less adsorptive to the coloring matter. By controlled sludge return, however, improved color reduction can be obtained, for the degree of color adsorption is dependent upon the sludge concentration.

Examples of Color Removal

To illustrate effective color removal, various installations can be cited.

A pilot plant was operated in the Northwest to treat a highly colored water which was low in alkalinity and hardness. The color varied during the test from 310 to 180, while the alkalinity varied from 63 to 51 ppm. and the pH from 6.9 to 7.0. When the color was 310 and the alkalinity 50 ppm., the alum dosage for optimum coagulation was 9.1 gpg. A dosage of approximately 0.9 gpg. of soda ash was required to maintain the pH at which the best floc formation was obtained. The effluent before filtration had a color of between 15 and 20, and the alkalinity and pH after treatment were 12 ppm. and 5.5 respectively. When treating a water having a color of 180, soda ash was not required, since the alum dosage was reduced to 6.7 gpg., reducing the color to 10. These test results compared very favorably with the settling basin plant in operation at the time.

Color determinations were made on the effluent of an Accelator designed primarily for silica reduction. The treatment was varied to maintain a pH of between 10.5 and 11.0 so as to secure essentially complete magnesium precipitation and silica reduction. In this instance, the color of the water was reduced from 17 to 2, which was much greater than had been expected.

In another case, an Accelator was installed in Louisiana to treat a bayou water having a color of 85, a turbidity of 160 ppm. an alkalinity of 72 ppm. and a pH of 7.1. This water is being treated with 6.0 gpg. alum and 2.0 gpg. sodium aluminate, reducing the color to 10 and the turbidity to 3 ppm. The treated water had an alkalinity of 6 ppm. and a pH of 6.3.

A somewhat different type water is being treated at Mineral Wells, Tex. This water has a color of 56, a turbidity of 30 ppm., an alkalinity of 87 ppm., a hardness of 97 ppm. and a pH of 8.2. This water is being treated with lime to decrease the alkalinity to 54 ppm. and the hardness to 85 ppm. The pH of the treated water is 8.8, but the color is reduced to 14.

Recently an Accelator was put into service to remove color from a typical swamp water having a color of 185, an alkalinity of 33 ppm., a hardness of 27 ppm. and a pH of 7.1. "Ferrisul" is being used as a coagulant and, at the optimum pH of 4.0, the effluent has a color of 8. However, the pH is being adjusted to 9.4 with caustic soda, causing a color increase to 12.

Future Applications

In closing, it may be mentioned that the advantages of controlled sludge recirculation are being applied to other fields of liquid treatment where coagulation or solids separation are required. Paper mills are realizing the advantages of this equipment for white water treatment to recover fiber and to reduce the organic matter concentration to help control slime formation. Recent pilot plant operations indicate excellent coagulation and decolorization when the equipment is applied to the defecation of raw sugar juices.

In addition to a large number of treatment plants installed in army camps and in essential industrial plants, this equipment has also been applied to the field of magnesium hydroxide precipitation. Also, in the synthetic rubber industry, considerable quantities of a clarified and completely softened saturated sodium chloride brine are required in certain of the processes. An Accelator unit is being installed in each of these plants for this treatment.

Michigan Water Works School on Wartime Maintenance of Water Service

ON April 20, 21 and 22, 1943, at the University of Michigan in Ann Arbor, there was held a water works school that was both remarkably well planned and effective in its operation and results. The school was sponsored by the Michigan Council on Defense together with the following cooperating and participating agencies: the Michigan Department of Health, the College of Engineering of the University of Michigan, the Michigan Section of the A.W.W.A., the Michigan Conference on Water Purification and representatives of the (federal) Office of Civilian Defense.

The purpose of this school was to present the necessity for maintaining a safe and adequate water supply under all conditions, including war, and to explain to those in attendance how such results could best be obtained with local personnel and materials. The program included discussions of mutual aid, prevention of sabotage (in relation to mechanical, chemical and bacterial injury), aerial bombardment and its effects on a water system, emergency water supplies, technical and special training of water works personnel, legal aspects of volunteer services, repairing mains, disinfection of pipes, emergency power problems and auxiliary units for emergency service.

Related to a discussion of "Water Supply in Wartime," prepared by R. L. McNamee, was a water department audit questionnaire to be filled out by the water works executive on his return to his home city. This was intended to be a self-appraisal and a guide to the executive in his presentation, to the proper authority in his city, the needs of the department. It appears so useful that it is reproduced herewith (page 602).

At the close of the conference, following John M. Hepler's review of the proceedings under the title "The Job Back Home," a second self-audit questionnaire on defense planning (*see* page 604) was given to each executive.

Finally, at the close of the last session, a brief true-false type examination was given. Each statement was based upon some point or statement in a paper that had been presented during the sessions. While the background of all the statements may not be clear to the readers of this JOURNAL, the idea involved is of such value that the material is presented herewith (page 607) for their study.

A total of 218 men registered for the sessions which began at 8:30 in the morning, adjourned for a 90-minute lunch period and carried on after dinner on two evenings until 10 o'clock. Each participant received a certificate as a visible record of his attendance. Far more valuable, however, were the gains to each water works man who at-

tended. Not only did he have a far better picture of his own responsibilities and problems, but he also understood better than he possibly could have before, the relation that water supply bears to the entire defense organization.

While references to persons always are in danger of omitting someone whose services are important, the planning and success of the school appeared to lie to the credit of John M. Hepler, State Voluntary Engineer & State Water Co-ordinator; Donald S. Leonard, Administrator, Michigan Council of Defense; Major W. H. Cary, Jr., Regional OCD Sanitary Engineer; Harrison H. Caswell, Chairman, Michigan Section, A.W.W.A.; Professor William C. Hoad, Engineering Department, University of Michigan; R. J. Faust, Secretary, Michigan Conference on Water Purification; and M. N. Gerardy, Secretary, Michigan Section, A.W.W.A. Meetings of this character can well be held in other parts of the country where the need of better understanding of an integration of water works to civilian defense may be evident. HARRY E. JORDAN, *Secretary, A.W.W.A.*

Self-Examination of Water Works Preparedness for Wartime Conditions

Water Works Plant at _____

WARTIME WATER WORKS LOAD

What is the present (1943) connected population?

What further population increase can be expected during the war period?

What total population should, therefore, be provided for?

What important water-using industries are now served?

What additional important water-using industries can be expected during the war period?

What are the characteristic variations in the rates of demand for water?

	Demand rates, in mgd., as an average for the:			
	Year	Max. Month	Max. Day	Max. Hour
What have been the normal peacetime rates?				
What are the present (1943) rates?				
What total rates should be provided for?				

PRESENT WATER WORKS PLANT

What are the capacities of the elements of the present plant?				
Sources of water?				
Intake or well structures?				
Source pumping plant?				
Purification plant?				
Distribution pumping plant?				
Distribution feeder mains?				
Sources of power?				

What is the status of plans, maps and records of all elements of the plant?
- Properties owned or leased?
- Intake or well structures?
- Source pumping plant?
- Purification plant?
- Distribution pumping plant?
- Distribution system?
- Sources of power?

What is the operating condition of all elements of the plant (particularly those infrequently operated)?
- Standby wells?
- Intake gates and screens?
- Standby pumping equipment?
- Standby purification equipment?
- Bypass pipelines and valves?
- Distribution system valves and hydrants?
  - Is rotation to open known and recorded?
  - Will they open and close fully?
- Standby sources of power?

AVAILABLE RESOURCES

What now undeveloped sources of water could be drawn upon?
- Natural sources?
- Supplies of other municipalities and industries?

What now unused pumping equipment could be put in service?

What now unused pipeline or pipe materials could be put in service?

What additional sources of power could be drawn upon?

VULNERABILITY

What are the critical features of the plant?

	Most liable to enemy attack or sabotage	Most essential to maintenance of service	Most difficult to repair
Sources of water?			
Intake or well structures?			
Source pumping plant?			
Purification plant?			
Distribution pumping plant?			
Distribution system?			

PLANT PROTECTION

What protective measures have been taken?
- Preparations for complete blackout?
- Equipment for floodlighting?
- Important properties fenced?
- Buildings and other structures kept locked?
- Histories of employees investigated?
- Identification for all employees?

MAINTENANCE AND REPAIRS

Have inventories been made of all material and repair parts stocks?

Has the use of substitute materials been studied?

Is emergency water sterilization equipment ready?

Is emergency construction equipment ready?

Are men trained for emergency operation and repair work?

(These general questions will suggest to the plant management and employees many more specific and detailed inquiries into the preparedness of the particular plant under examination.)

Survey of Maintenance and Protection of Public Water Supplies

Civilian Defense Questionnaire

	YES	NO
Integration With the Civilian Defense Activities		
1. Is the water works superintendent on the staff of the commander of the local U.S. Citizens Defense Corps?		
2. Will a trained water works employee represent the water utility at the local control center?		
3. Have you arranged for notification on an alert so that your force may be at their station before the general alarm sounds?		
4. Do emergency water works employees have proper identification under the civilian defense program so that they will not be interfered with by air raid wardens and auxiliary police while carrying out their duties?		
5. Is your water works control center properly tied in with the control center set up under the civilian defense program?		
6. Have you developed your own communication system so that it will function during a raid?		
7. Have you placed any curb on your employees engaging in other activities in the defense program?		
8. Have you arranged for notification of all emergency employees both during the day and at night?		
Maps and Records		
9. (a) Do you have complete and up-to-date maps of the water distribution system?		
(b) Are these maps made up in duplicate?		
10. Are copies of such maps kept in separate buildings and under fireproof protection?		
11. Are all valves on the system listed on such maps?		
12. Do you have reference data so that the valves may be found readily under unfavorable circumstances?		
13. Does information on valves contain data concerning right and left hand opening?		
Co-operation With Other Departments and Utilities		
14. Have you planned with the fire department officials for the use of auxiliary water supplies for fire fighting purposes?		
15. Have you planned with the health department for the sanitary control and supervision of such auxiliary water supplies as may be used for emergency domestic supplies?		
16. Have you planned with the power company for emergency sources of power supply in case of failure of your present source?		
17. Have you made arrangements with the local war defense plants to supply them with water in case of an emergency?		
18. Have you planned with other important agencies in the community concerning their particular need?		
Maintenance of Valves and Hydrants		
19. Do you have a routine valve operating program?		
20. Are all the valves on the system checked for operation at least yearly?		

	YES	NO
21. Are valves in important areas checked for operation at least twice a year?		
22. Is the water utility responsible for the maintenance and operation?		
23. Are all fire hydrants checked regularly for maintenance and operation?		
24. Do you notify the fire department promptly of all "dead" hydrants?		
25. Does the fire department notify you every time they use a fire hydrant?		
Anti-Sabotage Measures		
26. Have all water utility employees been checked for loyalty?		
27. Are visitors barred from the plant except on passes issued by some central authority?		
28. Have suitable locks been provided for:		
(a) Doors?		
(b) Windows?		
(c) Hatchways on reservoirs?		
(d) Other important structural openings?		
29. Have you made arrangements with the local police department for occasional inspection of important parts of your plant and system?		
30. Have you made arrangements with the Commander of the local U.S. Citizens Defense Corps for additional police protection during blackout or air raid alerts?		
31. Have you posted anti-sabotage "Warning" signs on water works property?		
32. Are supplies carefully checked when they are brought into the plant?		
33. Do you employ armed guards:		
(a) At the water plant?		
(b) At the water reservoir?		
(c) At other strategic points on the system?		
34. Are such guards alert and on the job at all times?		
Auxiliary Water Supplies		
35. Has an inventory of auxiliary water sources in the community been taken?		
36. Have you made arrangements for the use of such auxiliary water sources on short notice?		
37. Have you located a safe auxiliary water supply that could be used to serve your domestic needs?		
38. Have you arranged for treatment or sterilization of auxiliary water supplies that it may be necessary to use?		
39. Have you made arrangements for vehicular distribution of auxiliary water supplies in an emergency?		
40. Has an inventory of emergency sterilization equipment in the community been taken?		
41. Have you located all the supplies of chlorine and chlorine products in the community?		
Tools and Materials		
42. Are all tools used for repair work kept in good condition?		
43. Have you scattered your material and equipment at various locations?		
44. Have you made arrangements for the issuance of tools in the absence of the persons normally in charge?		
45. Do you have a material storage system which will allow quick and easy removal of heavy supplies?		
46. Have inventories been taken of the tools and materials that may be available from the community other than those in the water utility and other utilities in the community?		

	YES	NO
Equipment		
47. Have you arranged for the use of suitable power equipment for the efficient handling of pipes and other heavy material in an emergency?		
48. Has an inventory been made of the power construction equipment available in the community?		
49. Are operators of such equipment always on hand or subject to immediate call?		
Production of Water		
50. Do you have adequate standby pumping equipment?		
51. Has the possible auxiliary pumping equipment in the community been inventoried?		
52. Has an inventory been made of the prime movers that could be obtained in case of a power failure?		
Public Warning		
53. Have you made arrangements for the necessary public warning in case of an emergency?		
(a) By radio?		
(b) By newspaper?		
(c) By handbills distributed by air raid wardens?		
54. Have you prepared an outline of such a public warning so that it could be finished without loss of time?		
55. Have you arranged with the Health Department and the Commander of the U.S. Citizens Defense Corps as to whose responsibility such public warning will be?		
Emergency Training		
56. Have you established "in-service" training in emergency technique for your regular employees?		
57. Have volunteer auxiliaries been:		
(a) Recruited?		
(b) Trained?		
58. Have you carried out command post exercises?		
Sanitary Control of the Water Supply		
59. Have you increased your laboratory examination of water samples from the distribution system as a regular procedure?		
60. Have you planned for a much greater increase following an air raid?		
61. Have you arranged for additional laboratory facilities in the community other than those that are normally available to you?		
62. Have you arranged to increase the chlorine dosage in case an air raid occurs?		
63. Have you arranged for chlorination squads to assist the groups making repairs on the distribution system and in the handling of auxiliary water supplies?		

FINAL EXAMINATION

Correct answers will be found on p. 34 of the "News of the Field" section of this JOURNAL.

	TRUE	FALSE
1. Information on excess water works inventories can be obtained from the War Production Board in Detroit and the Michigan Department of Health in Lansing.	____	____
2. The Michigan Mutual Aid program is set up to function only in case of a bombing.	____	____
3. Bombers on a non-stop flight from Nazi-occupied lands would approach Michigan from:		
the east.	____	____
the northeast.	____	____
the northwest.	____	____
4. High-explosive bombs cause more property damage than fire.	____	____
5. Diesel- or gasoline-engine-driven pumps are ideal for pumping water from emergency supply sources.	____	____
6. Flushing is one of the principal requisites in cleaning a repaired main.	____	____
7. War gases would be less effective in destroying civilian morale than bombs or incendiaries.	____	____
8. Water works employees should not volunteer for civilian defense work which might interfere with their water works duties.	____	____
9. The fact that water pressures throughout a city are satisfactory for domestic and industrial uses is good evidence that they are adequate for fire service.	____	____
10. At least 50 ppm. of free Cl_2 is needed in sterilizing a repaired main.	____	____
11. The only necessary qualification for teaching is a thorough knowledge of the subject.	____	____
12. It is desirable for a water works to have its emergency program parallel its regular operating program as closely as possible.	____	____
13. It is easy to get a large number of people to execute an order uniformly.	____	____
14. The effect of constrictions in a pipeline depends upon the length of the constricted section as well as upon the area of the opening.	____	____
15. Damaged water mains must always be permanently repaired before other damaged services are repaired.	____	____
16. The dilution method is a test for free Cl_2 in a water sample.	____	____
17. A six-inch water main will supply all the water the fire department needs to fight a conflagration.	____	____
18. The gas mask furnishes protection against lung injuries from any of the war gases for a limited period of time.	____	____
19. In Michigan it is illegal for a city water superintendent to lend departmental equipment to a neighboring city.	____	____
20. When teaching another person how to do a job, the order in which the job is performed should be followed in every case.	____	____
21. If trained and experienced personnel of the water department have to be released to the Army or to war industry, their place can be readily and effectively filled by taking on the unemployed garage and gasoline station operators of the town.	____	____
22. It is the duty of the water department to notify the fire department at once of any "dead" hydrants on the distribution system.	____	____

	TRUE	FALSE
23. It is extremely difficult for an expert to discuss a job on the level of the beginner.	____	____
24. Co-operation between different utilities serving the same community should, as far as possible, be arranged on a two-way basis.	____	____
25. Extra police protection of water plants is needed during blackouts and air raid alerts.	____	____
26. Heavy clothing does not furnish protection against the blister (vesicant) war gases.	____	____
27. Every lesson regardless of its simplicity requires careful preparation.	____	____
28. 1000 feet of six-inch pipe will require more than one pound of chemical to give a concentration of 1 ppm.	____	____
29. If the 220-volt, 1740-rpm., 3-phase motor on one of your pumps were to be wrecked and your operations depended on this pump, you could use a 440-volt, 1760 rpm. motor of approximately the same frame size to drive the pump.	____	____
30. Shut-off keys for operating valves on street mains should not be furnished to the fire department.	____	____
31. A volunteer member of an auxiliary repair crew employed by a city water department cannot recover damages from the city for injuries received while in the performance of the repair job assigned to him.	____	____
32. The best method of thawing out a frozen hydrant is by the use of electricity.	____	____
33. Where rivers, lakes or ponds are available, it is possible to develop valuable auxiliary emergency supplies without pumping the water from such sources into the city's distribution system.	____	____
34. In case of a broken or crippled water main, the fire department should be at once notified about "dead" hydrants on the line.	____	____
35. Fencing and locking are among the most valuable protective measures that can be taken against sabotage of water plants	____	____
36. In general, the water works wartime operating problems of a large city differ from those of a small city only in size.	____	____

The Mutual Aid Training Program in Zone 22, New York State

By E. P. Stewart and H. H. Wagenhals

IN GENERAL, the mutual aid training program in Zone 22 (Onondaga, Oswego, Cayuga and Cortland Counties) has been in continuous progress since the institution of the state's mutual aid activities. Personal conferences and follow-up work in connection with preparation of the first general inventory were in many cases educational as to the needs and value of basic data relative to the distribution system, maintenance of valve records and co-ordination of activities with fire departments and other civilian organizations engaged in civilian defense activities. The mutual aid schools were, of course, the most specific and concrete part of the general training program, but they are not considered as constituting the program in its entirety nor as the final phase of such training. Contact is still being maintained with all water operators by the issuance of a short bulletin intended primarily to re-emphasize major aspects of the whole mutual aid program and to foster continued interest and activities in the program.

A paper presented on March 25, 1943, at the New York Section Meeting, Syracuse, N.Y., by E. P. Stewart, *Zone Co-ordinator*, Engr., Div. of Water, Syracuse Dept. of Engineering, Syracuse, N.Y., and H. H. Wagenhals, *Asst. Zone Co-ordinator*, Assoc. San. Engr., State Dept. of Health, Syracuse, N.Y.

The work of organizing training schools was begun in August 1942, when four evening meetings were held in the cities of Syracuse, Oswego, Cortland and Auburn. At these meetings representatives of several of the larger water supplies in each county were present to discuss and organize schools in the four counties of the zone. It was the consensus of opinion of all of the water works operators attending these meetings that one school should be held in each county for all lessons except those of a purely local nature, the latter to be held by the superintendent of the local water supply in his own community.

Combined Schools

The combined schools were held at Oswego, Auburn and Syracuse, Cortland County having decided to attend the Syracuse school for the combined sessions. In the interests of rubber and gas conservation, the city of Cortland chartered a bus which was used to bring not only its own personnel, but also the personnel from Homer and McGraw, to the Syracuse meetings. The villages of Marathon and Cinnatus in Cortland County did not participate in Zone 22 schools, having decided to attend the Binghamton school, because it was nearer.

The first combined session was held in Syracuse on September 29, the Au-

burn school opened October 2 and the Oswego school, October 6. Most of the sessions of the three schools were held in October, with field lessons following in November and December. All of the school work was completed by the first of the year, with the exception of a few special sessions which were held for the purpose of making up lost hours for several men who were unable to attend all of the sessions as originally scheduled.

Courses and Faculty

In the course of organization it was decided to combine some of the class or field lessons scheduled in Water Series Bulletin No. 1.* For the most part these combinations involved the grouping of allied subjects, which it was felt could be logically combined without detriment to the subjects covered. By this means it was possible to reduce the use of automobile transportation. It was also decided to eliminate Field Lesson No. 2 (Inspection of a Water Purification Plant) as there is but one rapid sand filtration plant in the zone. The total scheduled hours of all lessons are 32½.

The faculty of the schools for the combined meetings, included the Zone and Assistant Zone Co-ordinators and members of their respective staffs—A. A. Korves, Local Mgr., New York Water Service Corp., Syracuse Suburban Plant; Joseph Naughton, Supt., Water Dept., Solvay; Robert D. Kelly, Engr., New York Fire Rating Organization, Syracuse Office; Harold Milliken, San. Engr., Auburn Water Supply; William McCaffrey, Supt. of Water, Oswego; and I. W. Dudley, Chief Engr., Wells College Pumping Station. The Johns-Manville Corp. also co-operated in sending a representative to each of the three schools held in the zone to lecture and show pictures of bombings and main repairs.

Attendance and Certification

Total enrollment in all of the schools held in the zone was 279 men, of which 158 were regular water employees and 121, auxiliaries. Forty water supplies were represented in this attendance. A total of 136 men completed the course and have been recommended for certificates. Of these 86 were regular employees and 50 were auxiliaries.

Recommendations for certification were based on definite requirements, which were quite rigidly followed. Persons absent from more than two class or field sessions, thus completing less than 28 hours of actual work, were not recommended for certification. One general exception to this rule was made for operators of small one-man systems, where no auxiliaries were involved. Such men were recommended for certification even though local field sessions were not held, with the realization that at such field sessions the operator would be in the somewhat ridiculous position of being both instructor and student. In some few cases, too, exceptions were made where unusual conditions appeared to warrant qualifying individuals. Attendance requirements for the course as a whole, however, were quite rigidly maintained.

At the conclusion of the course, a final examination was held at each of the three schools. These examinations

* Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties. Water Series Bul. No. 1, State Office of Civilian Protection, Jour. A.W.W.A., **34**: 803 (1942).

were of the "True-False" type and, to avoid embarrassment, examination papers were not required to be signed. Review of the answers on the 106 examination papers turned in, was very gratifying, only a negligible number of papers failing to qualify for a 75 per cent grade. It was further found that the discussion of these papers was more general and active than at regular quiz sessions following individual lessons. These discussions brought out many points of value and presented many phases of the work in broader aspect.

While the schools were being organized, both zone co-ordinators felt that, for the most part, there was a lack of enthusiasm among water works operators for such a training course. In fact, in some instances, it seemed doubtful whether sufficient personnel could be enrolled to make the schools worth while. All water works men seemed to feel, however, that the work should be attempted as a part of the war effort program. After much effort on the part of the co-ordinators and of several of the enthusiastic water works operators, enough men were recruited to warrant holding the schools.

Beginning with the very first session, it was gratifying to the faculty to find that, not only was the attendance good, but the men attending the school seemed to be much interested in the subject matter presented. This interest not only held but in many cases increased during the course of the school.

An outstanding case of enthusiasm and conscientiousness in pursuing the studies was found in the case of the city of Cortland and the two villages, Homer and McGraw, which co-operated with it. Not only was the attendance of the regular employees and auxiliaries 100 per cent, but, to make a thorough job of it, the bus driver was inducted into the course and completed it satisfactorily.

It has been very gratifying to receive reports both from volunteers and regular water works employees to the effect that they found the material presented not only instructive but interesting as well. At the beginning of the course, the zone co-ordinators were rather appalled at the prospect of teaching a general course on water supply in 30 hours, but were later happy to find that the men who were really interested were getting something from the course.

Probably the two most disappointing features of the school were the indifference of water officials, in a number of communities, to the whole program and the relatively small number of auxiliaries. The bulk of the auxiliaries came from a relatively few communities. It is realized that many water supplies are not preparing to handle emergencies by the development of expanded organizations.

Conclusions

The following observations concerning this course were made by school officials:

1. Well prepared charts were invaluable in illustrating lesson material and were much to be preferred over blackboard illustration.

2. Motion pictures and lantern slides not only held interest and attention, but were also a great aid in teaching.

3. Informal lesson presentations seemed to secure better results than the reading of a lesson or any formal presentation.

4. It was difficult to stimulate discussion on the part of the students.

5. A "quiz" which was used in all

of the combined sessions showed evidence of attention and absorption of essential facts by most of the students.

One feature of the training school in Syracuse, which successfully stimulated interest and discussion, was an "Information Please" program, conducted by the Zone Co-ordinator with the heads of four of the larger water supplies as "experts." Everyone was invited to prepare questions on general operation and main repairs to be used in the program. This resulted in some discussion between the experts themselves and brought out the fact that there is more than one answer to many of the daily problems presented in maintaining the water supply.

Motion pictures were used to good advantage, both in stimulating interest in water supply generally and in illustrating the subject matter of the lessons. One film used was the "Omnibus Arms Case," illustrating the danger from inter-connections in plumbing. The other picture was "Portable Water Purification—Unit Model 1940," which gave a very good description of the Army's use of a portable filtration and chlorination unit. In addition, slides prepared and presented by Johns-Manville Corp. were instructive and well received.

It is felt that the school has been well worth while, even if no war emergency develops. It is also felt that the course was worth all of the effort involved for the training of regular employees alone, as it stimulated their interest in their work and prepared them for greater use in their organizations.

As mentioned at the beginning of these remarks, it is fully realized that the training program was not concluded with the holding of the schools, but that it must be continuous as long as war-created emergencies are possible. An effort is being made to maintain and foster interest in the mutual aid plan and to keep operators informed of developments by the use of a small bulletin issued from time to time, emphasizing various phases and activities of the program, commenting on developments as they occur and urging continued attention on the part of all operators. The last bulletin, for example, was devoted largely to the 1943 Spring Meeting of the New York Section of the American Water Works Association.

Acceptance and Use of A.W.W.A. Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe

By Deming Bronson and George B. McComb

IN the past decade of technical association history, it is probable that no specifications have been accepted so generally and in so short a time as have the A.W.W.A. Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe—7A.5 and 7A.6–1940. There was a definite need for these specifications and the specifications have filled that need. They have established orderly procedures which are practical, understandable, economical and effective. One of their merits is that, although their basic principles are firm, they can be used without restricting the judgment of the specifying engineer.

If acceptance is measured by use, it is significant that, since A.W.W.A. Specifications 7A.5 and 7A.6 were released early in 1940, they have been designated and followed in more than a thousand steel waterline projects. They have been accepted and used by scores of municipal and consulting engineers, by the U.S. Bureau of Reclamation, by the Bureau of Yards and Docks of the Navy Department, by the Office of the Chief of Engineers of the War Department, by the Los Angeles Department of Water and Power and by many other organizations. They have been employed too in most of the outstanding projects concerned with the war program, and, though it would be indiscreet to discuss these now, later, "when it can be told," the factual stories of design and construction involved will be of fascinating interest to all water works engineers.

Soundly conceived standard specifications in any field survive only because their use benefits all the interested parties. Specifications 7A.5 and 7A.6 are probably not without imperfections, and, undoubtedly, changes and amendments will be made from time to time; but these specifications will survive because they do meet this requirement of over-all benefit.

They benefit the owner of steel waterlines in serving to remove from his mind any doubt or uncertainty about unknown or untried procedures. On the basis of the specifications, he is assured of getting a job of known quality; and because an equal basis for competition is thus provided, he can be assured, too, of sound value.

They benefit the designing engineer who recommends them in that he does not have to "sell" them to anyone, in-

A paper presented on June 24, 1942, at the Chicago Conference by Deming Bronson, Vice-Pres., Hill, Hubbell & Co. Div., General Paint Corp., Cleveland, Ohio, and George B. McComb, The Barrett Div., Allied Chemical & Dye Corp., New York.

asmuch as they *are* the accepted standard. The options and appended data provided permit him to "cut the cloth to fit the body." The mechanical ease of specifications designation is to him a time- and energy-saving boon that is no reflection on his ability to write his own detailed specifications, as he would have to do if no standard were available.

They benefit the manufacturer and contractor in defining clearly properties and qualities of materials and laying procedures. Such definition removes uncertainty in competitive bidding in assuring all that they are bidding on the same thing. Manufacturers of materials covered by these specifications are able to reduce inventories, to get faster stock turnover, to develop the best equipment and technique and to train their men in the making of standardized products. While these specifications are established and in effect, this does not mean that study and work toward the further improvement of the materials and products have ceased. The inherent American zeal for improvement will continue to prevent self-satisfaction and stagnation.

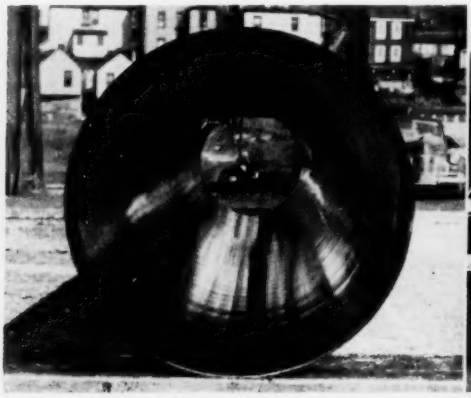


FIG. 1. Typical Centrifugal Coating or Lining Results

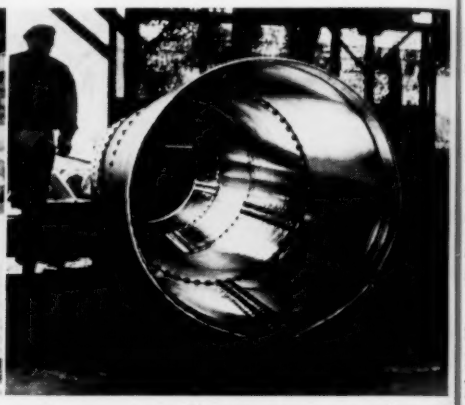


FIG. 2. Old Riveted Line—reconditioned by blasting and welding deep pits, then lined and coated as provided in A.W.W.A. Specifications 7A.5

Both Specifications 7A.5 and 7A.6 are easy for the engineer to use. Because no basic designation can properly include details peculiar to a particular project, the engineer must, himself, make the detailed designations. The mechanism provided in the specifications for this purpose, however, is simple. It is impossible here to cite all the combinations of details for which the specifications provide, but two examples will demonstrate the simplicity of the method:

1. Mr. Engineer has a 42-in. line that is to be laid underground in a trench dug through rock, although all other conditions are "normal." This warrants the use of sand shield. His complete specifications designation would then read:

"Interior and exterior pipe protection shall be provided in accordance with A.W.W.A. Specifications 7A.5 plus Section A5–1.2."

2. Mr. Engineer has a $10\frac{3}{4}$-in. od. line, most of which is to be laid underground in ordinary soil with part of the line carried on the caps of a bridge.

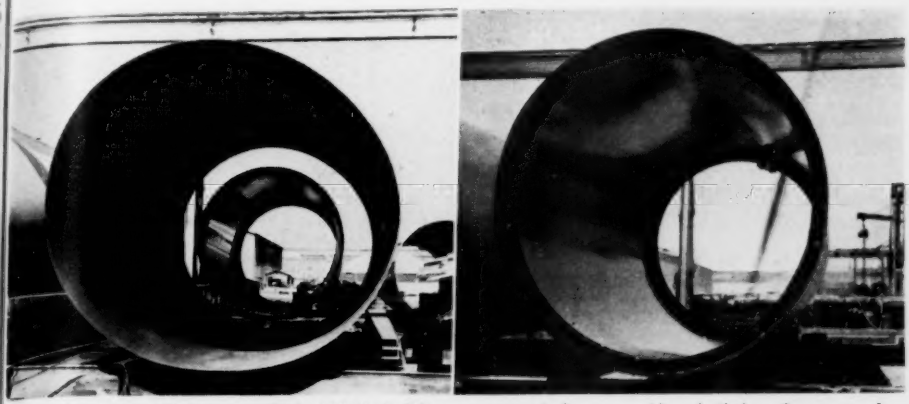


FIG. 3. Large-Diameter Thin-Walled Pipe, prepared for centrifugal lining by use of Removable Stiffener Rings which are removed as soon as lining is complete

His complete specifications would then read:

"The interior protection of all the pipe and the exterior protection of the buried pipe shall be in accordance with A.W.W.A. Specifications 7A.6, and the exterior protection of the exposed pipe shall be in accordance with Section 6–5 thereof."

Bearing in mind that the fundamentals and many of the details of Specifications 7A.5 and 7A.6 are similar, it is interesting to note the remarkable range of steel pipe size within their combined scopes. This range has included protection of pipe as small as $2\frac{3}{8}$ in. od. and as large as 120 in. od., with penstocks for dams up to 156 in. The $2\frac{3}{8}$-in. line will carry a water supply for only a few families, while the 120-in. line will adequately supply thousands. The coal-tar enamel linings in both these sizes of pipe have the same essential physical and chemical properties, yet they serve the same purpose in both lines with equal success.

Successful results with coal-tar enamel linings in this wide range of pipe sizes are achieved by proper preparation of the interior pipe surface, proper application of the prescribed primer and finally by skilled application of the prescribed enamel. The purpose of the following explanation of the two basic methods—trough method and retraction method—of mechanical application of the lining enamel is to emphasize the point that equally satisfactory results may be obtained by either method.

In the trough method, a single trough, the full length of the pipe, or a pair of troughs, each half the length of the pipe to be lined, containing a pre-

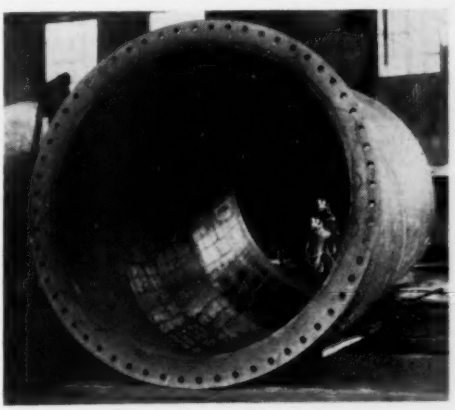


FIG. 4. Typical Hand-Applied Enamels to Specials

determined quantity of hot coal-tar enamel, is inserted into the pipe. Unsupported from within the pipe, the trough (or pair of troughs) is held stationary after the proper speed of rotation of the pipe has been obtained. Then the trough is turned on its own longitudinal axis so that the enamel is emptied relatively slowly over the lip of the trough into the interior surface of the pipe. The outward thrust of centrifugal force created by the fast revolving pipe evenly disperses and levels the molten enamel before it congeals. The method is essentially the same whether the full length trough or two half troughs are used. The practical limit of structural design of the trough determines this choice.

The retraction method employs the principle of pulling an end-discharging supply line the full length of the pipe to be lined as the pipe revolves on its longitudinal axis. The amount of hot coal-tar enamel discharged is keyed to the rate of retraction and to the area of the interior pipe surface, i.e., to the diameter of the pipe. The discharging end of the supply line may be fitted with a weir or simply with some form of spreading nozzle or orifice. In either case, the practice is to discharge the hot enamel at nominal pressure at or near the bottom of the horizontal pipe cylinder. At the same time care is taken to assure an adequate, uniform and uninterrupted flow or discharge of the hot enamel during the complete outward traverse of the supply line. The weir is most frequently used in the lining of relatively large pipe and the spreading nozzle or orifice most often for the smaller sizes. In either case the centrifugal force of the revolving pipe plays its part in dispersing and leveling the applied hot enamel before it "sets up" to firmness.

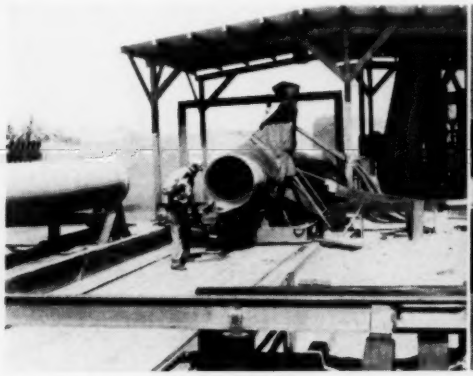


FIG. 5. Automatic Blasting Equipment—cleans interior and exterior surfaces to bright metal in one operation

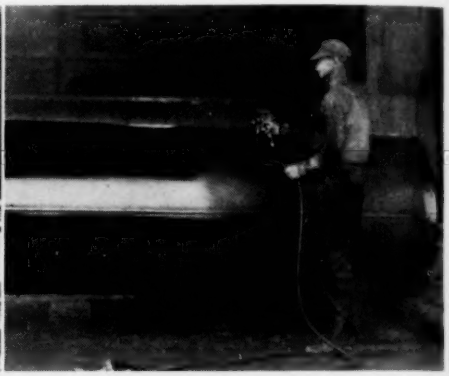


FIG. 6. Spray Application of Coal-Tar Primer—as provided in A.W.W.A. Specifications, which permit either spray or brush application

With the equipment in good working order and in the hands of experienced operators, there is no choice between the trough and retraction methods as far as smoothness, thickness uniformity and quality of the applied enamel lining are concerned. There is, however, a direct tie-in between the results with either method and the A.W.W.A. standard specifications for steel water pipe (Specifications 7A.3-1940 and 7A.4–1941). These specifications prescribe limits for the round-

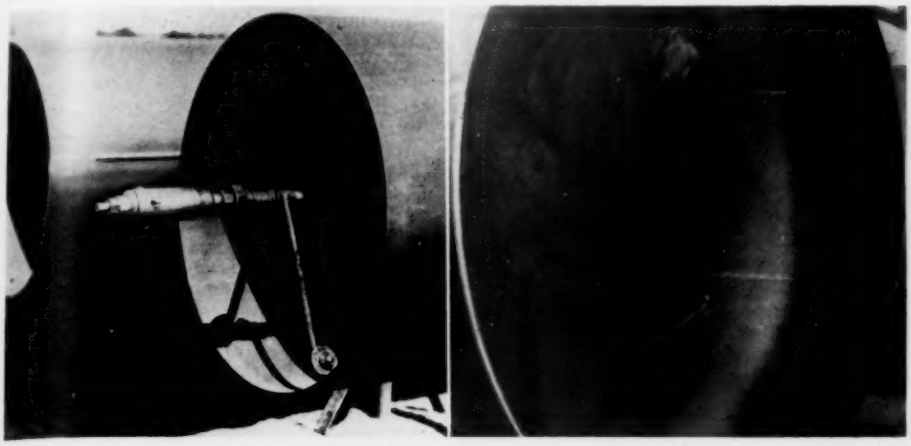


FIG. 7. Interior Application of Coal-Tar Primers is usually accomplished by 360° air guns (*left*) up to approximately 36-in. diameter pipe and by hand (*right*) in the larger diameters

ness and straightness of the pipe itself; and, if the pipe is beyond these limits, any attempted enamel lining job will be substandard. Out-of-round pipe causes uneven thickness of lining—thick on one side, thin on the other. A crooked pipe will not revolve smoothly on its own axis and the resulting "whipping" will cause noticeable spirals to form in the enamel lining. The increasing co-operation of the steel pipe manufacturers in reducing these difficulties has been commendable.

The coal-tar enamel protective coatings prescribed in Specifications 7A.5 are being used according to the application principles established therein on many different types of structures other than pipe. Trash racks of intake towers, outlet works, penstocks, steel tunnel linings, dam gates, desilting units, sewage installations, irrigation gates, marine vessels and structures, caissons and steel pilings—a few examples—have all been lined with coal-tar enamels according to the procedures recommended in these specifications.

From time to time engineers have questioned some of the details of these specifications. More often than not, these questions have been prompted by a sincere and proper desire to know more of the "reasons why." Some questions, however, have challenged the severity of certain parts of the specifications. For this reason it is appropriate to explain some few of the points questioned most frequently.

Any protective coating system, regardless of the purpose it serves, depends upon adhesion to the underlying base materials. In pipe, dirt and mois-

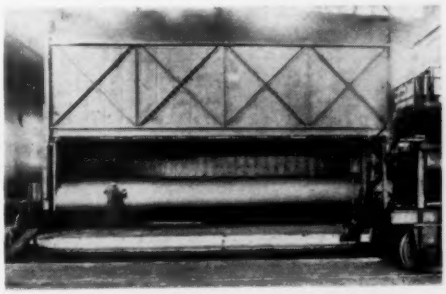


FIG. 8. Typical Hot-Air Space, for warming pipe before priming and for warming the primed pipe before the lining and exterior coatings are applied

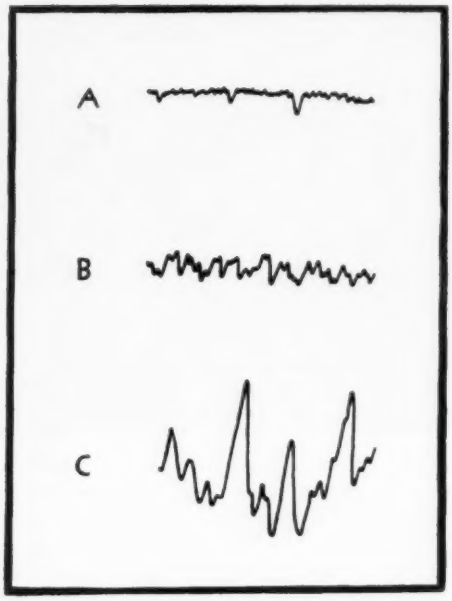


FIG. 9. Surface Contours of Various Roughened Solids: *A*—as received, cold rolled steel; *B*—100-mesh silicon carbide, 30 psi. air pressure; *C*—60-mesh steel grit, 30 psi. air pressure

(Magnification—4700 Vertical, 210 Horizontal; Radius of Stylus, 0.0005 in.)

ture on the steel surfaces are the two worst enemies of permanent adhesion. In their recent book,* Burns and Schuh have described an ingenious method for determining the surface contour of various roughened solids, which indicates that steel-grit blasting greatly increases the surface area and joint strength of coating materials on the metal. A grit-blasted steel surface is made up of many tiny facets, inclined toward each other at various angles. This condition undoubtedly helps to key the coatings to the surface by neutralizing stresses normal to it. The major benefit from grit blasting, however, is the removal of foreign material, which action results in improved performance.

Figure 10 illustrates the gains in coating adhesion to be obtained by proper cleaning of surfaces. Both the illustrated plates were primed and enameled under identical conditions and both were tested at 40°F., as provided in Section 5–2.5(d)3 and in Section 6–2.4(d)3 of Specifications 7A.5 and 7A.6, respectively.

The primers required under these specifications perform two functions. First they serve as a *bonding agent* for the enamel; and, for this purpose, application is important. The primer must be spread evenly and must be heavy enough to leave a strong residual film when dry; if spread too thin as a liquid, the residual dry film will be too weak to provide strong bond. Secondly, the primer serves as a *protection* to shop-cleaned pipe during

* Burns, R. M. and Schuh, A. E. *Protective Coatings for Metals.* Reinhold Publishing Corp., New York (1939).

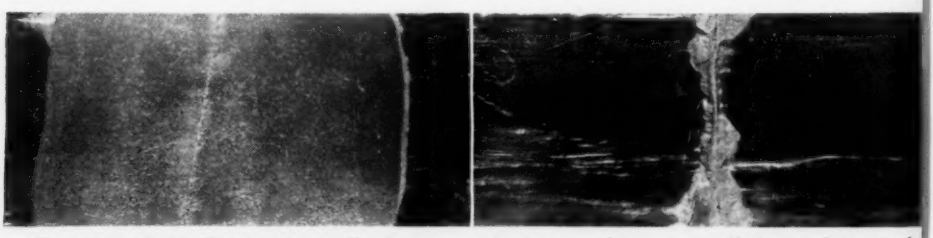


FIG. 10. (*Left*) Substandard adhesion, secured when coatings are applied over improperly cleaned steel; (*Right*) Proper adhesion secured when coatings are applied over properly cleaned steel. Materials and application in both cases identical; plates tested by bending according to Section 5–2.5(d)4 of A.W.W.A. Specifications 7A.5

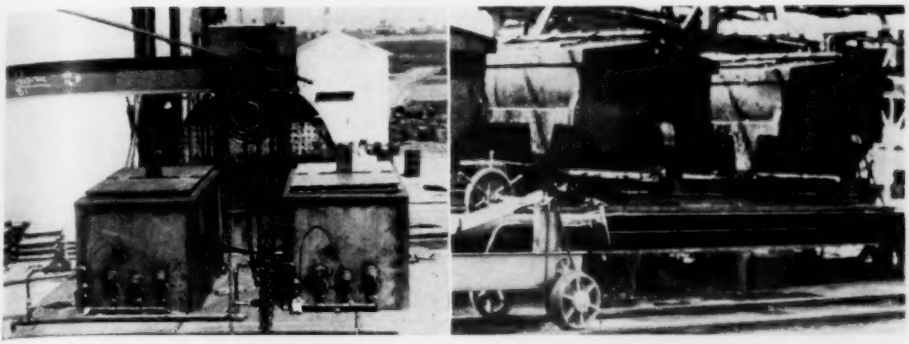


FIG. 11. Two Types of Supply Kettles—these are elevated to discharge enamels by gravity to Operating Kettles, Troughs or Coating Cars; Supply Kettles are fired and emptied in rotation, which provides a constant supply of enamel without undue heating

transit or storage, when the pipe is to be lined and/or coated and wrapped elsewhere than at the place of manufacture. In such cases, of course, an additional application of primer is required before linings and coatings are applied. Test panels on which the primer has been applied too thinly or on which it is "dead" (older than 72 hr.) show results similar to those on the unclean panel illustrated in Fig. 10.

In industries producing finished metal items, such as automobiles, furniture and refrigerators, successful practice requires that the metal be moisture-free before protective coatings or finishes are applied. Similar provision is made in both Specifications 7A.5 and 7A.6. The stipulation that steel pipe temperature shall not be less than 45° F. is a conservative precaution taken to guard against application of protective coatings when the pipe temperature is at or below the dew point. It is sometimes difficult to detect condensed moisture on pipe, so all successful applicators are alert on this subject. One practical method of warming pipe is shown in Fig. 8.

Specifications 7A.5 permit the use of either of two types of coal-tar enamel to provide the materials best suited to the particular construction.

Type A Coal-Tar Enamel is an elastic product of relatively high penetration (7 to 16 at 77°F.) which offers high resistance to deflection and bending, such as is apt to occur with thin-walled pipe, and which resists exposure to low temperatures without cracking.

Type B Coal-Tar Enamel is of somewhat lower penetration (3 to 8 at 77°F.). This "harder" enamel, as an exterior coating, offers greater resistance to soil stresses and is also suitable for penstock and tunnel linings, for the protection of underground tanks and for use on pipe installed in extremely hot climates.

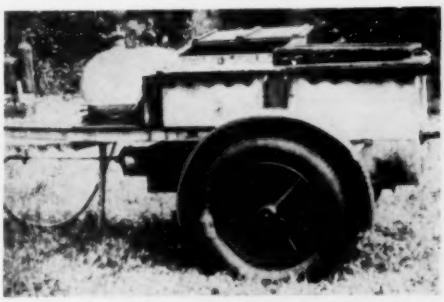


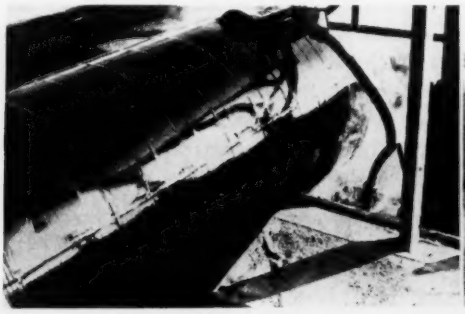
FIG. 12. Ideal Type of Kettle, for making field joints and necessary repairs

Although both these types of enamel are essentially the same, the principal difference is that Type A enamel has greater elastic qualities.

Specifications 7A.6 permit the use of only Type A enamel, because its higher penetration is desirable in meeting pipe-handling, construction and transportation conditions. Because all small-diameter pipe is lined and coated and wrapped in production mills or fabrication plants, provision for the protection of applied coatings during transportation or storage must be made. Type A enamel permits the general use of protected steel pipe in all seasons of the year. Steel water service pipe as small as 2⅜ in. od. has been successfully lined and coated and wrapped because this type of enamel

FIG. 13. Insulated Carrying Bucket, for transfering enamels from kettles to daubing buckets

FIG. 14. Electrically Heated Daubing Bucket With Thermostatic Control, insures enamels applied at correct temperature



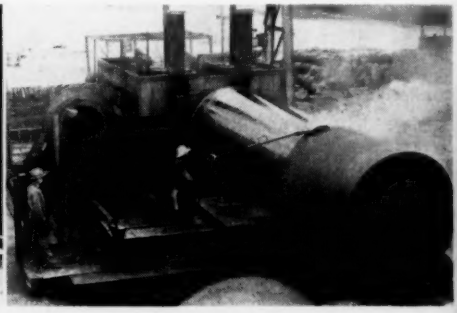


FIG. 15. Two Views of Floating Spreaders—coal-tar enamel is pumped from the operating kettle to a distributor head, where a floating spreader in the enamel applies it in overlapping spirals

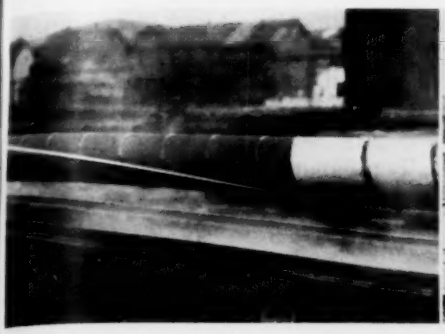


FIG. 16. Continuous Wrapping Operation: on small diameter pipe, the protective wrapping can be applied in a continuous operation.

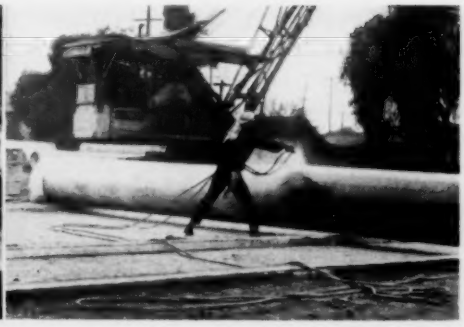


FIG. 17. Application of A.W.W.A. Formula Whitewash, normally reduces black surface temperature as much as 40 per cent

permits handling and normal deflection of the pipe lengths even in cold weather.

As far as is known, the only thing that adversely affects the expected life of coal-tar enamel coatings is overheating, particularly by the heat used to reduce the enamels from solid to liquid form for application. Certain qualities are built into the enamels by their manufacturers, so that their recommended procedures for melting and heating the enamel to application temperatures must be followed precisely.

The size of melting and heating equipment best suited to the individual use is most important. The heating cycle includes the time required to bring the solid enamel to application temperature and the time the enamel is held at application temperature. Both these factors must be carefully supervised.

Exterior coatings are usually pumped to some form of weir or

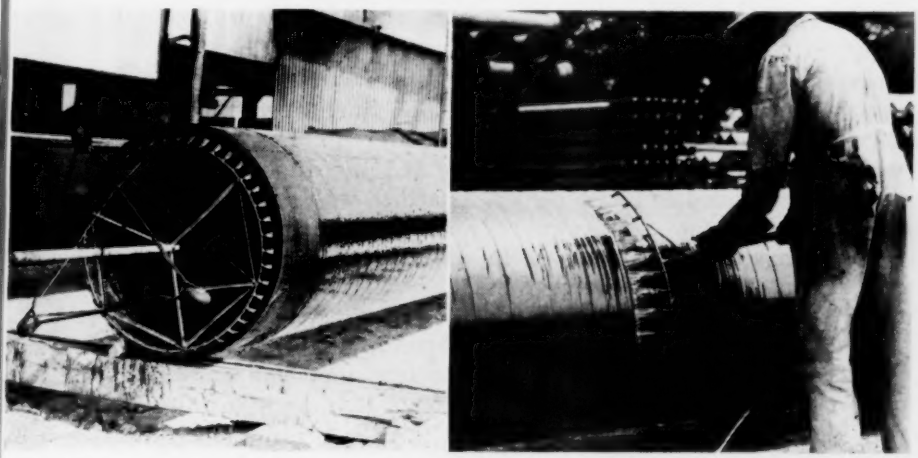


FIG. 18. Two Types of Electrical Detectors Used for Inspection: (*Left*) Umbrella Type, for interior lining; (*Right*) Segment Type, for exterior coatings—Various types are based on type of construction and conditions

spreader, permitting the coal-tar enamel and the felts to be applied spirally. The use of Kraft paper or whitewash on coated and/or wrapped pipe serves important purposes in handling and laying the pipe. As defined in Specifications 7A.6, the Kraft paper on coated and wrapped small-diameter pipe prevents the pieces from sticking together in transit or storage and serves as an indicator of damage. Most important, however, is the fact that it reflects the sun's heat, reduces pipe temperature and cuts down expansion. This results in less strain on field-welded or mechanical joints during laying and backfilling operations.

of inspection has raised the quality of protective coating application and, more than any other single factor, has made employees conscious of the necessity for quality application.

Through experience, methods have been developed that assure delivery of protected pipe at its destination in sound condition, with coatings intact. Among the equipment used are properly padded saddles of adequate width, cut to the curvature of the pipe. Linings are protected from locomotive cinders by end-closures. The specifications require the use of spiders or stiffeners when the deformation of the pipe exceeds 2 per cent of the diameter.

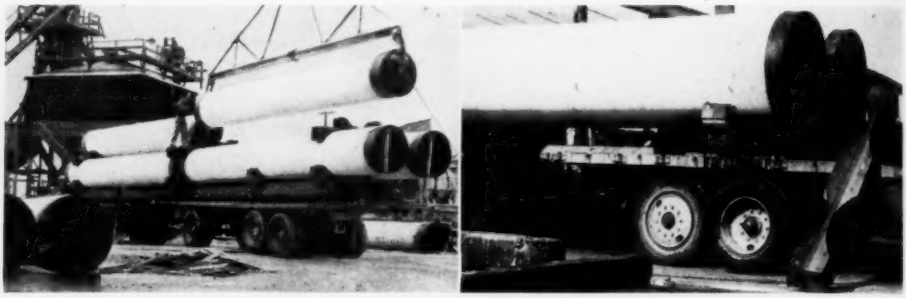


FIG. 19. Padded Bolsters Cut to Pipe Curvatures, protect pipe and coatings during truck transit and illustrate good practice as provided in A.W.W.A. Specifications

Inspection staffs, construction engineers and enamel applicators have all developed electrical inspection apparatus of various designs and types. All of them are intended to locate defects or "holidays" in the electrically resistant coatings by causing a spark to arc from the electrode to the steel of the pipe, thereby locating voids or damaged areas which otherwise would not be found. In principle, these devices are all about the same, but the power units vary with local conditions —storage battery units are used in the field while transformer types are plugged into shop circuits. This kind

Engineers' inspectors have become more familiar with the specifications requirement that all pipe shall be stored on skids, that pipe shall be handled with slings and that pipe shall not be rolled on the ground. All these practices, by their wide use, emphasize the value of these specifications.

The exacting requirements in both Specifications 7A.5 and 7A.6 for the protection of both coupled and welded joints have been justified in practice. Until the present time, the minimum size of pipe on which welded field joints have been used successfully is 20-in. od., inasmuch as pipe smaller

than that does not permit entry and working space for application of lining after the weld is made.

Although but little more than two years old, these specifications have already enjoyed remarkably wide circulation and acceptance. As engineers and owners become still more familiar with them, confidence will grow, thus extending their use even further.

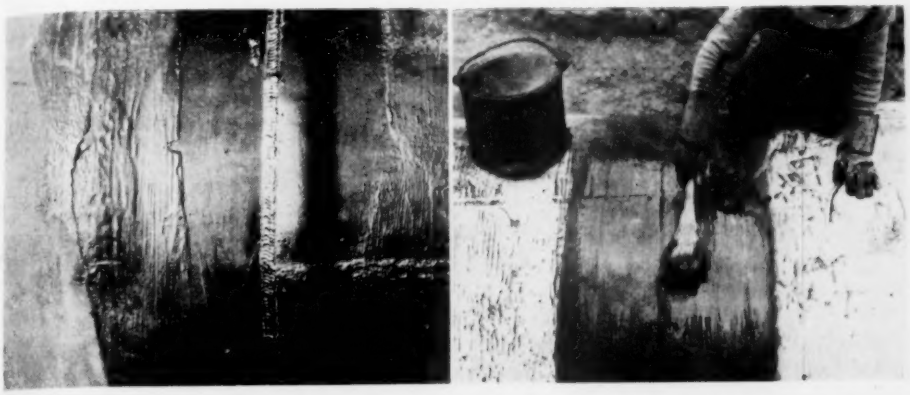


FIG. 20. Cleaned and Primed and Enameled Exterior Welded Joints—After welding and testing, exterior and interior weld beads and pipe areas on each side of the weld are thoroughly cleaned and primed, then enameled; this is followed by a wrapping of asbestos pipeline felt which is bonded to the underlying enamel, overlapping the shop-applied coating for at least 4 in.

Abstracts of Water Works Literature

Key: In the reference to the publication in which the abstracted article appears, **34:** 412 (Mar. '42) indicates volume 34, page 412, issue dated March 1942. If the publication is paged by the issue, **34:** 3: 56 (Mar. '42) indicates volume 34, number 3, page 56, issue dated March 1942. Initials following an abstract indicate reproduction, by permission, from periodicals, as follows: *B.H.—Bulletin of Hygiene (British); C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (British); I.M.—Institute of Metals (British).*

WARTIME WATER WORKS PROBLEMS

How War Affects Water and Sewage Operations and Treatment. R. F. GOUDEY. Western City **19:** 2: 24 (Feb. '43). Author sharply criticizes present conditions relating to water and sewage problems incident to military expansion and development, citing instances of alleged bad planning and faulty laboratory control. "Increased federalization" claimed on basis of: (1) "extension at least in advisory capacity, of U.S.P.H.S. into every local detail regarding water and sewage plant operation," and reference to proposed set of revised stds., submitted by U.S.P.H.S. to Advisory Com., as "not only drastic, but high-handed and applicable to all"; and (2) U.S.P.H.S. telegram of Dec. 9, '41, in part, urging proper officials in charge of domestic water supplies to take certain immediate steps against sabotage and to step up Cl_2 dosages to provide disinfecting action throughout distr. system. In Southwest, "order was generally laughed off as impractical because of temp., slime, length of distr. lines and storage which made such recommendation ridiculous," while compliance observed by some New England states even though "New England generally known as area which disinfects its sewage, but drinks its raw water." Constructively, author recommends: (1) creation of eng. post as cabinet officer in charge of all water supply and sewage disposal constr. for military, war indus. and civilian interests; and (2) set up new section in Army Eng. Corps responsible for water supply safety and purif., as well as sewage disposal from health standpoint. [Recommendations appear to suggest further "federalization."] Warns every water and sewage plant operator to be alarmed as to possibilities of sabotage and need for reinforcing safety measures, recommending their co-op. with U.S.P.H.S. in its security program for protecting plant and property facilities. Key men should practice incidents day and night with local civilian defense; get as many fittings and supplies as able and recommended by OCD Bul. No. 1 (*abstracted*, Jour. A.W.W.A. **35:** 105 (Jan. '43)); list items needed in emergency and det. where then obtainable; have copies of OCD *Gas Defense Bul.* and *War Gases* by Jacobs. Elimn. of all cross-connections resolutely urged. Water and sewage operators should install fish tanks below all reservoirs to detect poisons in water supply; test for significant bacteria in water by using "crystal violet followed by 44°C. incubation from lactose broth and thereby differentiate between organisms of significant and non-significant strains"; be alert for chromium wastes which have upset biol. processes in English war centers; construct Bovee bubbler to test for war gases (*see* later abstract in this section); more than ever need to conserve water supply, use reclaimed sewage for agric. purposes, simplify operations and get along as well as possible. Should curtail pub. relations; repair sections only where fire or health indicate; keep lists of reserve personnel, including plumbers, up to date; employ women for telephone, record and pump operation, and possibly in making repairs.—*Ralph E. Noble.*

Wartime Economy and Operation of Water Works. E. G. B. GLEDHILL & A. W. H. MCCANLIS. Wtr. & Wtr. Eng. (Br.) **44:** 48 (Mar. '42); *Discussion. Ibid.* **44:** 113, 142 (May, June '42). (*Abstracted* Jour. A.W.W.A. **34:** 1261 ('42). *Authors' Closure. Ibid.* **45:** 211 (Dec. '42). Restriction of flow through valve manipulation responsible for greater wastage of fuel than any other single item except, perhaps, inefficient boiler-house control. Facilities for varying speed of prime mover can make considerable difference to fuel bill. Advantage might be taken of reserve power and overload capac. in motors. Efforts to reduce water waste produce most important results in search for economy. In early days of war, demand for fire services training increased quants. of water used for practices and hydrant tests. Matter of co-op. between water companies and army authorities. In waste inspection and detection surveys, if men can be spared for attendance at valves, adequate supplies will be available for fire fighting. Reservoir tests provide pos. method of estg. total waste in whole area of supply and proportion taking place in each reservoir zone. If water hammer experienced when using rubber compn. washer, may be due to deg. of hardness of material. Rubber washers now unobtainable; other materials being exptd. with for cold-water taps rather than reverting to use of leather, while for hot-water taps red fiber washers being used. Advantages and disadvantages of softening whole supply during war appear fairly evenly balanced. On one hand, expense of chems., labor and fuel, and, on other hand, saving of soap. If concn. of solids in boiler water maintd. near max. permissible (750 gpg. for Lancashire boilers), substantial saving of fuel will result as compared with maint. of concn. of 100 gpg. Continuous blowdown preferable to intermittent operation. Passing blowdown through pipe immersed in feed tank simplest method of recovering some heat. If feed tank kept small as possible, heat losses by radiation and conduction min. No difficulties need be expected with feed pumps due to high-temp. feed unless exhaust steam from non-condensing engines or from leaking traps and steam drains finds way into feed tank. Where pumping levels in wells at same site different, advisable to connect whole system by adits, although not feasible in wartime. Undesirable practice is custom of pumping over standpipe before discharge into reservoir to maint. sufficient head to supply premises on high ground near reservoir. If supply large, waste of fuel substantial. Soln. is to zone off high level area and install small booster plant.—*H. E. Babbitt.*

Ground-Water Supplies in Kansas Available for National Defense Industries. S. W. LOHMAN, J. C. FRYE, H. A. WAITE, V. C. FISHEL, T. G. MCLAUGHLIN, B. F. LATTA & E. ABERNATHY. Kan. State Geol. Survey, *Bul. 41* ('42). Report calls attention to availability in many parts of Kan. of large water supplies from wells or streams for use by national defense indus. Summarizes water qual. from wells in different parts as to suitability for indus. use. Supplies of from 10 to more than 20 mgd. available for continued use from well groups in Mo., Kan. and Ark. R. Valleys. Somewhat smaller supplies available in other parts of state, particularly western. Supplies larger than those stated available for few years during present emergency. Information given re parts in which ground water supplies enough for use by national defense plants generally not available.—*Ralph E. Noble.*

Meeting a War-Induced Water-Shortage Crisis. ANON. Am. City **57:** 12: 58 (Dec. '42). Navy yard activities at Kittery, Me., increased water consumption 50% to 3.0 mgd. Combined with drought, depleted town's 2 reservoirs. FWA with Lanham Act funds installed emergency pumping plant and pipeline laid on ground surface. Installation diverts 3.0 mgd. from another watershed into existing reservoirs. Gravity dam on reservoirs, built 7′ higher than old structure, provides 200 mil.gal. addnl. storage.—*F. J. Maier.*

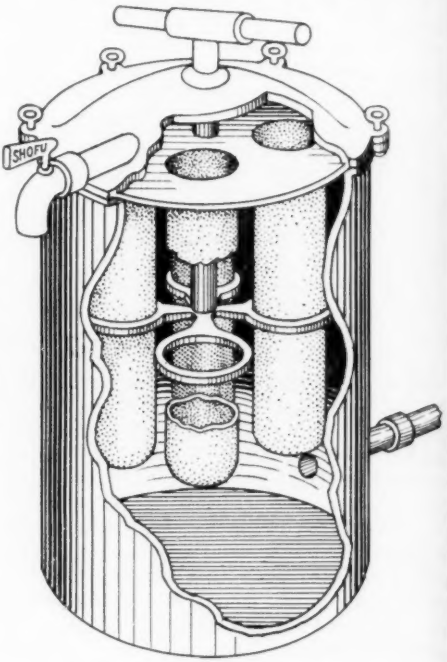
Protection of Civilians From Vesicant Agents. T. F. BRADLEY, J. T. CASSADAY, T. G. MOORE & WM. C. MOORE. Chem. & Eng. News **21:** 373 (Mar. 25 '43). In treating vesicant burns, speed of counteractive measures so essential that self-aid rather than first aid may be advocated. Mobile first aid and decontamn. units considered superior to fixed casualty stations on grounds that: no long continued gas attack probable, save costs in establishing fixed centers, possible destruction of fixed centers, possible loss of utility services, possible excessive contamn. of bldgs., loss in time handling casualties, large staffs and relief necessary, many transport vehicles needed, training of drivers and large amt. of anti-gas equip. necessary. At Stamford, Conn., volunteer mechanics mounted steel body of anti-

quated garbage truck, 12′ x 7′ x 5′, on 1½-ton Dodge chasis; installed four 60-gal. galv. insulated hot-water boilers on roof and connected by ¾″ pipe to 2 sets of 3 shower heads separated by curtain down center of truck. Access by wooden ladders, one on each side. Each compartment has wooden bench locker, inside which protective equip. stored. Cost $600. Doctor, nurse and 2 chemists of opposite sex man truck. Personal equip. includes sodium bicarbonate soln. for eye wash, dry absorbent pads for dabbing off vesicant, tourniquet and salt tablets for blocking heat exhaustion of workers in special clothing. Chlorox applied to skin as first aid against either liquid Lewisite or mustard. Water tanks filled when alert sounds. Aerosols OT and OS, at 0.2% concn., greatly improve wetting and dispersion of vesicant liquids by water. Simpler truck arrangements suggested include pressure water tanks and cylinder of compressed air on floor of moving vans with flexible hose to showers without interference with normal operation of truck.—*A. A. Hirsch.*

Bubbler for Detection of War Gases. CLIFTON BOVEE. W.W. & Sew. **89**:12:529 (Dec. '42). To det. proper medical treatment, evacuation measures and decontamn. procedures necessary for gases used on civilian pop., Bureau of Water Works & Supply of Los Angeles developed app. to detect types of gases. Consists of 12″ wood frame supporting six 25 × 200-mm. filter tubes fitted with stoppers through which glass tube extends to bottom of bubblers. Sidearms of bubblers connected to glass suction manifold. Suction supplied with water aspirator, automobile windshield wiper connection or intake port of gas mask canister. Bubblers contain reagents of gold chloride, sodium iodoplatinate, potassium permanganate, methyl orange, silver nitrate and sodium sulfide. Combined changes of color or formation of turbidity identifies 12 gases almost instantly. 55 units made at cost of $4.10 each. [*Cf.* Western City **19**:1:15 (Jan. '43)]—*F. J. Maier.*

Gas Defense. ANON. Western City **19**: 2: 13 (Feb. '43). Real mustard gas used in gas defense courses in War Dept. civilian protection schools at Univ. of Wash., Stanford Univ. and Occidental College, where soldiers and civilians train together. Gas protective suits and training masks used identical to those supplied to decontamn. squads in target area cities. Instruction procedure illustrated and described briefly.—*Ralph E. Noble.*

The Shofu Cylinder. *A Japanese Method of Water Filtration in the Field.* RICHARD D. KIRKPATRICK. Mil. Engr. **35:** 113 (Mar. '43). "Shofu filter" (*see* diagram) small cylinder about 2½′ high, 18″ diam., 150 lb. wt., and constructed of heavy metal with either nickel or chrome finish. Main body of cylinder welded into single hollow chamber with one tapped opening for water inlet. On top of cylinder body rests heavy casting cap attached by large shackles with wing nuts. When in place and securely clamped, entire unit withstands high pressure. Four clay filters, each 1′ by 4″ diam. cylinder of porous clay baked hard and brittle, affixed to cap by waterproof joint and suspended therefrom inside large metal cylinder. Joints threaded to permit filter replacement when damaged. Around each clay cylinder is brush connected with other brushes and piston running up through cap center to handle for manipulation to scrub off impervious film collecting on outside filter surface. Many addnl. clay filters supplied with each field unit for replacements. In operation, impure water flows under a head



into cylindrical, metal chamber. Induced head pressure forces water through porous clay where gross impurities removed and water cleared. Same initial head forces clear water out through faucet in cap at max. rate of 4 gpm. Any deposit collecting on outside clay filter surface noticeably retards flow and requires brush scrubbing. Individual Shofu filter, slightly modified, found used with others in group of 4 on truck serving as mobile water filtration unit. In addn., truck equipped with pump, storage tank, hose and spare parts. Effluent apparently pure enough for ordinary Jap. consumption. As extra precaution, however, Cl_2 compds. in capsules might be added in containers of filtered water. Marine units on Guadacanal found Shofu unit cooled slightly and made water more palatable. Jap. filtration units found ready for operation apparently not intended for use with chlorinators.—*Ralph E. Noble.*

The Pollution of Municipal Water Supplies by the Use of Chemicals and Bacterial Cultures. HARRY E. BARNES. Southwest W.W. Jour. **24:** 9: 14 ('42). Only chems. to worry about are those which produce arsenic (Lewisite), cyanide, mustard gas and chlorpicrin. Unlikely that sufficient bact. contamn. could be attained to produce any hazard.—*O. M. Smith.*

The Personal Factor in Accidents. *Medical Research Council. Ind. Health Res. Bd.* (London) *Rpt. No. 3* ('42). Terms of ref. of Ind. Health Research Bd. stress necessity for making widely known results of such completed researches as capable of useful application to practical needs. Emergency rpts. issued by Bd. since outbreak of war directed to that end. Conclusions stated as simply as possible and with min. of tech. detail, so that practical implications easily understood by non-specialist reader. This third rpt. in series deals with personal factors to be taken into acct. in any intelligent effort to lessen incidence of accidents in industry. First part describes effects of general factors such as hours of work, environmental conditions, technical aspects, preventive influences and some personal factors of general kind, such as age and experience. Second part devoted to discussion of accident proneness. During war of 1914–18 shown that excessively long working hours resulted in increase in accident rate; evidence that fatigue played substantial part in accident causation. Longer working hours necessary in wartime, but effects can be mitigated by rest pauses in middle of work spells, by change of occupation, by alternate sitting and standing where possible, and by proper adjustment of bench or machine to worker. In munition works in last war, accidents at min. when shop temp. 65° to 69°F., and frequency rose considerably when temp. much above or below that range. In coal mines accident rate found to increase as temp. becomes uncomfortably high. Ventilation and warming of factories should be controlled to ensure satisfactory thermal conditions. Inadequate lighting or presence of glare may be a contributory cause of accidents. Too great variation in illumination must be avoided. Inexperience fruitful cause of accidents. Worker may be unaccustomed to factory life or merely inexperienced in particular operation he is performing. Training of new entrants on non-production basis, rather than allowing them to pick up technique in course of production, so that necessary habit formations can be acquired under expert tuition and without regard to speed, great advantage in avoiding acquisition of faulty and clumsy movements. Quite apart from inexperience, young people more liable to sustain accidents than older persons. Young people have poorer muscular co-ordination than adults; and youth is age of irresponsibility. Long periods of repetitive work readily tire young persons, and occasional changes of occupation, e.g., leaving bench to get fresh material, beneficial. Persons physically or mentally unsuited to work liable to incur accidents. Any method of selection that will prevent grosser misfits will contribute to accident prevention. Many accidents due to speed of production. After age of about 40, capac. for rapid movement deteriorates. Desirable that elderly workers not be employed in new occupations where very rapid movement essential. If such employment inevitable, workers should be given adequate training period. Inefficient routing systems responsible for many accidents. Goods should not be left lying about in passageways. Attitude of the management or of workers may contribute to accident causation. Managements should not regard accidents as fortuitous and inevitable, and workers should avoid carelessness and dangerous practices. Statistical establishment of "accident proneness" as unfortunate characteristic of section of mankind—and finding that this to some extent predictable by psychological tests—due largely to original

researches carried out on behalf of Bd. Liability to accident largely detd. by deg. of risk to which person exposed, but within single working group, members of which exposed to equal risk, found that some persons sustain more accidents than others. Psychological investigations show that those with unduly high accident rate can be partly differentiated on basis of measurable individual reactions; and these individual differences represented by phrase "accident proneness." Accident proneness narrower term than accident liability, for it refers only to personal factors tending toward high accident rate. Seems that accident proneness relatively stable factor, manifesting itself in all periods of exposure and in different kinds of accidents. For nearly 20 yr., investigators at work to find tests predicting accident prone, who commonly comprise 10–25%, of any group. Best results yielded by tests measuring capac. to respond accurately, within controlled time interval, to various sensory stimuli. Tests, however, only valid for prediction among skilled workers. Hitherto no relation found between these or other tests and accident rate in unskilled occupations. In skilled occupations in which tests applicable, those who do well in tests not only have lower accident rate, but also more proficient. If found that certain young people in dept. sustain more accidents than others of equal age and experience who do same work, safe to regard them as accident-prone. Should be diverted to another dept. where risks less. Use of psychological tests to predict accident proneness has obvious advantage of indicating likelihood of individual's sustaining undue no. of accidents before he is exposed to industrial risks; and if extensively carried out, method should serve to lower general accident rate. Keeping of proper accident records most important in study of accident causation. Sample of card that will give all necessary information given. *All* accidents should be recorded.—*B.H.*

Fatigue and War Production. R. H. FLINN. *Med. Clinics of North America* (July '42). p. 1121. U.S. Public Health Service recently made statement on workers' health and 24-hr. schedule which contains no. of unexceptionable pronouncements, but conclusions on change-over of night shifts contradict extensive evidence obtained by Brit. Health of Munition Workers Com. U.S.P.H.S. maintains that day and night shift workers should not change over every 2 or 3 wk., as they find it difficult to adjust their eating and sleeping habits. Should therefore change over every 2 or 3 mo. Health of Munition Workers Com. recommended change over *every week* for great majority of workers, when on night shifts, never get quiet and undisturbed rest during day; but any loss of sleep then experienced can be made up for in alternate day-shift weeks. Weekly change-over almost universal custom in continuous processes such as met with in iron and steel industry.—*B.H.*

HEALTH AND HYGIENE

Hypothetical Relationship of Water Supplies to Poliomyelitis. KENNETH F. MAXCY. Am. J. Pub. Health **33:** 41 (Jan. '43). Author in conclusion states "at present insufficient evidence to justify belief that water is medium of any practical importance in spread (of poliomyelitis)." Hypothesis that disease may be water-borne not new one. Up to '37, idea received little support, but in past 5 yr. many advocates recruited. Expts. and post-mortem studies indicate virus of poliomyelitis *enters* through the alimentary tract, but do not resolve question as to whether conveyed by air particles—droplets, droplet nuclei or dust—or *via* contamd. articles, food or drink, or by both. Similarly, lab. studies leave doubt whether nasopharyngeal secretions or intestinal discharges, or both, of importance as medium of *exit* for virus in order that it may reach new hosts. Demonstrated that virus may be present in stools of persons not clinically ill, or with illness of ill-defined character, as well as in those of persons suffering from paralytic or recognized abortive attacks. Virus found in stool of child after 123 days from attack of mild case of suspected poliomyelitis. Facts suggest that in nature, human fecal material copious source of virus and that virus traced for short distances and limited time periods in domestic sewage. In large set of tests on sewage, only in 4 instances was virus recovered in samples collected close to hospitals in which infantile paralysis patients treated; in 87 routine sewage samples collected at approx. monthly intervals in N.Y. City and New Haven, 85 neg. and 2 pos. Theoretically possible that virus in polluted water might pass through water purif. treatment process adequate to retain or destroy *Esch. coli*. Safety stds. based on *Esch. coli*

as index and on typhoid fever experience would not necessarily apply to infantile paralysis problem. Still matter of uncertainty if residual chlorine values carried in swimming pools will inactivate virus of poliomyelitis. Up to present, with one possible exception, no one has conclusively demonstrated presence of poliomyelitis virus in water used for drinking or bathing purposes, even though such possibility exists. Studies and evidence discussed consistent with hypothesis poliomyelitis may be water-borne, but also consistent with hypothesis this mode of transmission is unimportant. Evidence not inconsistent with hypothesis that virus in feces inconsequential in transmission and that effective exit for transfer to new host made by air-borne secretions of upper respiratory tract. Author reviews characteristics of water-borne diseases, i.e., poor san. environment, explosive character of outbreaks and decrease or disappearance of disease with improvement in water supply; in connection with poliomyelitis states "epidemiological evidence of this character conspicuous by its absence."—*Martin E. Flentje.*

Efficacy of Standard Purification Methods in Removing Poliomyelitis Virus From Water. HARVE J. CARLSON, GERALD M. RIDENOUR & CHARLES F. MCKHANN. Am. J. Pub. Health **32:** 1256 ('42). Methods of water purif. commonly employed, namely coagulation and sedimentation, sand filtration, adsorption on activated charcoal, aeration, adjustment of pH and storage, have failed when tested individually to remove completely poliomyelitis virus from artificially heavily contamd. water. Ultraviolet irradiation from artificial sources has effect on destruction of virus in water greater than that exerted by direct sunlight and more effective in inactivating or destroying virus suspended in water than any single purif. method commonly utilized.—*C.A.*

Polio Virus and Water Purification. HARVE J. CARLSON, GERALD M. RIDENOUR & CHARLES F. MCKHANN. Eng. News-Rec. **129:** 933 (Dec. 31, '42). Poliomyelitis virus repeatedly demonstrated in sewage. Recent investigations disclosed that disease may be contracted *via* gastrointestinal tract. As water may therefore be hazard in transmission of disease, expts. carried out to det. effects of usual methods of purif. on virus. Presence of virus in treated waters detd. by inoculation into test animals. Virus remained viable in sterile tap water for as long as 100 days when stored at refrigerator temps. Alum flocculation and sedimentation appeared to effect slight reduction, proportional to amt. originally present. Filtration through sand not effective, but when preceded by alum treatment, allowing sand to become impregnated with floc, only 1 of 54 mice inoculated developed paralysis; and paralysis less extensive than in most control animals. Application of activated C, in dosages of 10–50 ppm., effected partial removal. Confirmed by fact that high percentage of animals succumbed to injection of settled activated C. Ultraviolet irradiation also tried, varying distance from source of radiation, depth of suspension and period of exposure, and found quite effective, particularly with longer exposure periods. Further studies of effect of combination of these treatments will be conducted.—*R. E. Thompson.*

The Effect of Aluminum Hydroxide Sedimentation, Sand Filtration and Chlorination on the Virus of Poliomyelitis. J. EMERSON KEMPF, MARTHA G. WILSON, MARJORIE E. PIERCE & MALCOLM H. SOULE. (*Published in abstract only.*) J. Bact. **45:** 78 (Jan. '43). Well established that poliomyelitis virus occurs in feces of patients with this disease, of healthy contacts and in sewage. As water poln. with this virus possible, expts. made to det. whether water purif. procedures, $Al(OH)_3$ sedimentation, sand filtration and chlorination inactivate or remove virus. Latter not removed from water by $Al(OH)_3$ and filtration methods which did remove 99.6% of *Esch. coli*, but removed from artificially inoculated water by producing $Al(OH)_3$ sediment of 1.5 ml./l. Virus not inactivated by this procedure, however, but remained in sediment in greater concn. Samples from 3 of 4 random water purif. plants contained insufficiently high concn. of $Al(OH)_3$ to sediment poliomyelitis virus. MV strain inactivated by 1.5 ppm. Cl_2 for 25 min. while DG strain required 1.0 ppm., but not 0.9 ppm. in same period. These Cl_2 concns. exceed those recommended for producing safe drinking or swimming pool water.—*Ralph E. Noble.*

Specific Prophylaxis Against Enteric Diseases. STUART MUDD. (*Published in abstract only.*) J. Bact. **45:** 61 (Jan. '43). Because of relative serological homogeneity of *Eberthella typhosa* and (2) long prodromal stage in which *Eberthella typhosa* in blood-

stream and reticulo-endothelial depots, typhoid fever most favorable opportunity among enteric diseases for vaccine prophylaxis. Opportunity fully exploited with result that typhoid incidence reduced steadily and at rate out of proportion to other enteric diseases. TAB vaccine currently distributed from Army Med. Center may be considered satisfactory prophylactic against typhoid fever. It produces substantial immunity also against heterologous strains of *Salmonella paratyphi, schottmuelleri, enteritidis* and *typhimurium*, but relatively ineffective against "suipestifer" or paratyphoid C groups. Against coliform organisms contg. *Salmonella* antigens, and those suspected of being etiologically related to diarrheal outbreaks, signif. amts. of protective substances found in sera of humans vaccinated with Army TAB vaccine. Protection against large residual group of paratyphoid fevers and *Salmonella* "food-poisoning" infections presents unsolved problems of considerable magnitude. Reactions to whole bact. vaccines definitely limit no. of organisms, and hence antigenic coverage practicable to incorporate in whole bact. vaccines. Chem. components at cell-wall surface of virulent bact. cell, e.g., smooth somatic antigens of *Salmonellas*, however, are antigens with which antibodies must react to give anti-bact. immunity. Cholera vaccine in current use and efforts made to maint. and improve qual. Many regard dysenteries second in importance only to malaria throughout tropical and subtropical areas. Bacillary types far more common and likely to occur in epidemic form than amebic. Currently reported that relatively mild *Shigella paradysenteriae* infections more prevalent than more severe *Shigella dysenteriae* (Shiga) infections. Vaccines to increase resistance to *Shigella* infections not used because of their excessive toxicity. Urgent need, therefore, to obtain bact. surface antigens in form to retain immunizing potency without such toxicity. Author believes urgent need to solve possible efficacy of cholera and dysentery bacteriophages as prophylactic or early therapeutic agents. Attention called to fact that during cold season, when respiratory infections prevalent, household outbreaks common in which some members show mainly respiratory, some mainly gastro-intestinal symptoms and some both. Possibility that these infectious diarrheal disturbances due to virus or other unidentified causal agent worth investigating.—*Ralph E. Noble.*

The Dysentery Carrier. ANON. Lancet (Br.) **244:** 146 (Jan. 30 '43). In bacillary dysentery, infection confined to bowel without systemic spread. When dysentery bacilli excretion continues after patient clinically well presumably organisms living on bowel mucosa or in unhealed ulcers. Dysentery ulcer may be present without clinical evidence thereof. Nevertheless, many mild Flexner and Sonne infections indicate convalescent carrier state often occurs without persistent mucosal lesion. Belief supported by frequency of symptomless carriers among clinically infected case contacts. Carrier state persistence longer than 6 mo. rare in bacillary dysentery. Occurrence, however, probably always associated with bowel ulceration and intermittent diarrhea (chronic diarrhea). Convalescent carriers common and half clinically infected cases may excrete organisms 3–4 wk. after onset. In contact carrier, infectivity more evanescent. Incident with statistics cited to show dysentery may be endemic in institution with high carrier rate but with few clinical cases until large admission of new patients when infection flares again, e.g., in mental hospitals. Detection and control of unsuspected convalescent carriers important. Detection greatly facilitated by desoxycholate agar, with fecal specimen preferable to rectal swab. Latter more convenient, however, in young children. Once detected, carrier control best effected by isolation until 3 consecutive neg. cultures obtained, although criterion possibly doubtful in some carriers. But many mildly infected cases and symptomless carriers never detected and, therefore, hand-washing facilities for post-water-closet use must be more generally provided and practice instilled by propaganda and education. Use of sulfa drugs for prevention and cure discussed.—*Ralph E. Noble.*

Dysentery Carriers in a Prisoners-of-War Camp. *Medical Research Council.* Monthly Bul. Emergency Pub. Health Lab. Service (June '42). Investigation for carriers completed among all prisoners at Italian prisoners-of-war camp with recent history of enteric or dysenteric disease. Total of 3 carriers of *Shigella dysenteriae*, 1 of *Shigella ambigua* and 1 of *Shigella paradysenteriae* discovered. Information concerning length of time for which patients may remain carriers after attack of dysentery still deficient; most recent data refer to Sonne type, and successful fecal cultures have depended upon use of new selective

media. Few years ago very experienced observer stated he had never encountered person carrying dysentery bacilli who appeared healthy and did not have symptoms of chronic dysentery. Notes concerning those carriers among Italian prisoners therefore of interest, as they demonstrate occurrence of apparently healthy chronic carriers of *Shigella dysenteriae* and *Shigella ambigua.—B.H.*

Paratyphoid Fever—An Epidemiological Study. W. SAVAGE. J. Hyg. (Br.) **42:** 393 (July '42). Study of 40 British outbreaks of paratyphoid from '23 to '41, supplemented by data from certain Am. epidemics. Table included gives data on the 40 British outbreaks —place, date, no. of cases, deaths, vehicle and suggested source of infection of vehicle. 40 outbreaks included 4255+ cases. Of 3947 of these cases 54 resulted in death. Water was vehicle in only 1 outbreak; synthetic cream in 9; milk in 8; direct infection and cream cakes in 3 each; cream, ice cream and confectionery in 2 each; and cream cheese, tongue, watercress, hospital food, bread and homemade trifle in 1 each. No vehicle found in 4 outbreaks. Suggested sources of infection for the 40 outbreaks as follows: contamd. water in 2; chronic carrier in 6; ambulant case in 3; temporary carrier and notified case in 2 each; infected employee in 1. Source undetected or unrecognized in 8 outbreaks and not ascertained in 16. Recorded case-mortality of 1.76% in whole series would probably be even lower if all mild cases in fact notified. Figure similar to that (1.5%) for cases of salmonella food poisoning. *Symptoms:* Some cases in outbreak, or even all cases in some outbreaks, may start with diarrhea, vomiting and acute pain, sometimes, but not always, passing, after interval, into illness of true enteric type. Disease may thus resemble acute food poisoning; e.g., in Consett outbreak of '40, 9 of 56 cases had gastro-intestinal symptoms only, 34 had these initial symptoms followed by typical enteric picture, 7 had typical enteric and 6 had symptomless infection. *Incubation Period:* Variable, ordinarily from 7 to 24 days, but usually shorter than in typhoid. Most usual period 10–12 days, but with large infecting dose may be as short as 4 days. Facts suggest that organism passes along intestinal lymphatics to sites of growth in mesenteric glands, liver and spleen. Process occupies incubation period, at end of which symptoms appear and bacteraemia present, followed by excretion of organism into intestine and invasion of Peyer's patches. *Age and Sex Distr:* Depend on vehicle and type of persons consuming it; e.g., children largely victims where ice cream is vehicle. *Season:* 60% of outbreaks started in May, June or July, with epidemic prevalence a little later. No special autumn incidence; seasonal distr. resembles that of salmonella food poisoning rather than that of typhoid. *Vehicle:* Cream responsible for 40% of outbreaks, food (excluding water) for 80%. Compared with typhoid, water-borne epidemics very rare and no outbreak due to shellfish. Search of literature showed this was general finding in all countries and that in few authenticated water-borne outbreaks, poln. was of gross and continued nature. Ample proof (from Epping, Edinburgh and elsewhere) that *Salmonella schottmuelleri* may be found in sewage and effluents, and that it may be demonstrated in district for years after outbreak. With exception of one outbreak in present series due to water, one to watercress and three institutional outbreaks in which case-to-case spread followed the introduction of a carrier, all ascertained sources of infection foods in which *Salmonella schottmuelleri* could multiply. Prominence of cream, especially artificial cream, probably due to facts that it is good medium for growth when temp. high and that it is liable to handling by operatives. *Vehicle Infectivity Rate:* As organism can grow in most vehicles one would expect high proportion of cases in pop. at risk. Not so; outbreaks often intermittent and not explosive. Factors influencing this are bactericidal action of normal gastric juice and temp. If vehicle kept for time in warm weather, rate will be high; e.g., in Consett 40 outbreak, where this occurred, 56 guests of 64 at wedding attacked. *Primary Sources of Infection:* Chronic carriers (*viz.*, those continuing to excrete bacilli after a year) occur, but percentage of paratyphoid cases which become chronic carriers not known. Convalescent carriers common. *Infections Without Clinical Manifestations:* Almost invariably present when looked for, proportion varying in different outbreaks. Outbreak at Gothenburg quoted in which 15 new-born babies in maternity hospital infected, all but one being practically symptomless without even rise of temp. One baby harbored bacilli for 7 mo. *Sources of Infection in This Series:* In not more than 2 outbreaks was there any reliable evidence of responsibility of chronic carrier

and in both there was element of doubt. Importance of ambulant unrecognized case and subclinical infection evident. Too often, however, such person, with opportunity to infect vehicle, located and assumed that he is infective carrier responsible; but he may be victim of present outbreak. Therefore, essential to det. this if possible by finding date of infection, whether consumer of food in question, by studying his previous history of illness and bact. history, i.e., variations in profusion of excretion of organism and level and variation of agglutination titers on repeated estn. Salmonella schottmuelleri *as Cause of Disease in Animals:* Where organism accurately identified, practically no evidence for this, with possible exception of several recent outbreaks in Scandinavia associated with dogs (*see* Bul. Hyg. (Br.) **15:** 159 ('40)). *Varieties of* Salmonella schottmuelleri: Author finally propounds attractive theory which may explain certain differences in epidemiology of paratyphoid and typhoid fevers. *Salmonella schottmuelleri* true salmonella in evolutionary stage from common ancestor, organism like *Salmonella typhimurium*, of catholic distr. and undifferentiated in its host selections. Becoming differentiated in direction of pathogenicity to one host. Irritant properties, which operate to secure speedy expulsion, not compatible with successful single-host parasitism. Unlike *Salmonella typhimurium* in man, therefore, *Salmonella schottmuelleri* instead developed invasive power associated with growth in body organs and bacteraemia. Has not progressed so far as *Eberthella typhosa* in respect to invasive, as opposed to irritant, properties, so that paratyphoid infection milder, incubation period more variable, true chronic carriers less likely to be common and organism possibly not yet quite an obligate human parasite. Since heavier infection with paratyphoid bacillus also necessary for successful invasion, outbreaks associated with vehicles in which organism can multiply. —*B.H.*

A Summary of Recent Work in the Control of Triple Typhoid Vaccine. GEORGE F. LUIPPOLD. (*Published in abstract only.*) J. Bact. **45:** 98 (Jan. '43). Author discusses 2 problems connected with triple typhoid (TAB) vaccine control: (1) selection of strains of vaccine organisms and (2) range of immunologic coverage produced by inoculating humans with TAB product. Selections of strains of *Eberthella typhosa*, *Salmonella paratyphi* and *Salmonella schottmuelleri* based upon their immunologic potency in lab. animals. Antigenic content, as detd. by agglutination tests with diagnostic *Salmonella* sera, unreliable index to organisms' immunologic potency. Decisive for organism's acceptance should be its performance, as vaccine, in animal body. TAB vaccine prepd. at Army Med. School possesses effective immunologic coverage over component organisms and antigenically related *Salmonella* types. Relatively ineffective, however, against "suipestifer" or paratyphoid C group. Coliform organisms contg. *Salmonella* antigens also considered possible pathogens against which TAB vaccine may be called upon to protect. Inoculation of TAB vaccine produced, in blood serum of human subjects, signif. amts. of protective substances active against a coliform strain contg. *Salmonella* O-antigens I and II (as in paratyphoid A), and against second strain contg. O-antigens IV and V (as in paratyphoid B).—*Ralph E. Noble.*

Typhoid Vaccine Studies. V. GEORGE F. LUIPPOLD. Am. J. Hyg. **36:** 354 (Nov. '42). *Antigenic coverage* not synonymous with effective *immunogenic coverage.* Must consider at least 3 characteristics: *identity, quant.* and *qual.* Antigen identity alone, as detected by diagnostic agglutination tests, not certain guarantee they will effectively protect against organisms endowed with same antigens; nor is quant. *per se* the determinative factor, as coliform A 1-Typhoid 63 combined vaccine contained "more" I, II, and XII antigens than Para-A organism itself. *Qual.* of contained antigens seems most important factor considered in selecting organism as vaccine culture. By "qual." is meant capac. of bact. suspension prepd. as vaccine, to protect animal body against heterologus strains of vaccine organism. Practical importance of studies centers around avoidance of accepting misleading criteria for selecting desirable vaccine strains of enteric organisms. *Antigenic completeness of organism desirable; but performance in animal body still only reliable index to organism's immunogenic capac.* Callender and Inmon, '37, noted significant drop in morbidity of all diarrheal diseases in U.S. Army following, by some mo., introduction of *S. schottmuelleri* into typhoid vaccine, and corresponding increase in these diseases following withdrawal of Para-B fraction from T.A.B. vaccine. They surmised that antigenic factors of bacteria used for typhoid (and paratyphoid) im-

munization may influence morbidity of diarrheal diseases, and noted striking correlation between morbidity changes and changes in composition of enteric vaccine. Sharing of *Salmonella* antigens by coliform organisms already known, but only recently Bornstein *et al.*, reported occurrence of *Salmonella* antigens in genus *Shigella*.—*Ralph E. Noble.*

Fluorine and Dental Health. Pub. Am. Assn. Advancement Sci. **19**:1 ('42). *Mottled Enamel: Early History and Its Unique Features.* FREDERICK S. MCKAY: Acct of history of mottled enamel (dental fluorosis) and of discovery of its etiological relationship to F content of drinking water during period of tooth formation. *Geographical Distr. of Endemic Dental Fluorosis (Mottled Enamel).* H. TRENDLEY DEAN: Review, with 47 refs. *Chemistry of Fluorine as Related to Fluorosis.* H. V. SMITH: Discussion of: (1) relationship of F content of drinking water to endemic dental fluorosis; (2) removal of F from water by filtration through treated bone, (e.g., calcination at temp. of 600°C., followed by treatment with dil. acid) or by use of H_3PO_4+CaO, MgO, $Mg(OH)_2$, or activated Al_2O_3; (3) bleaching stain in mottled enamel by means of concd. H_2O_2 or hypochlorites; (4) influence of fluorides on dental caries; and (5) role of F in agric. and physiol. chem. and in nutrition. 32 refs. *Investigation of Physiol. Effects by Epidemiological Method.* H. TRENDLEY DEAN: Epidemiological method applied to endemic dental fluorosis. Measurable dental characteristics of physiol. effects of F ingestion (index of dental fluorosis) as observed in 5824 white children of 22 cities in 10 states found associated with F concns. of pub. water supplies in relatively precise quant. relationship. 15 refs. *Review of Dental Fluorosis Studies at Univ. of Minn.* WALLACE D. ARMSTRONG: Incidence of rat molar caries reduced by extra F in ration: (1) during formation of teeth, (2) concurrently with caries-producing ration and (3) when administered to mature animals in high concn. in drinking water for period preceding use of that ration. Apparently F may have beneficial effect in prevention of dental caries. 21 refs. *Fluorine and Dental Caries With Special Reference to* L. acidophilus. PHILIP JAY: Difficult to draw definite conclusions from data now available relative to inhibition of dental caries through water supply. That F-bearing water associated with low communal dental caries rates seems incontrovertible. Further than that, well to proceed with caution. Not known whether or not addn. of NaF to water supply previously free of F will reduce communal dental caries attack rate. 16 refs. *Résumé of Fluorine-Caries Relationship.* GERALD J. COX & MARGARET MATUSCHAK LEVIN: Caries-resistant teeth can result from pre-eruptive diets; F one factor in formation of such teeth. No post-eruptive effect of F under normal conditions as yet demonstrated. When all facts known, toxic effects of F will be far outweighed by beneficial effects in prevention of dental caries. 18 refs. *Fluorosis Studies at Univ. of Rochester.* J. F. VOLKER: No definite conclusions can be drawn as to exact mechanism by which F inhibits dental caries. *Mottled Enamel From Standpoint of Public Health Dentist (Including Relation of Fluorine to Dental Caries in Illinois).* CHARLES F. DEATHERAGE: Group of persons exposed to F during first 8 yr. of their lives and group (age 21–28 yr.) exposed to F during their entire lives had lower dental caries experience and higher rate of teeth with no caries experience than persons exposed to low amts. of F, all other factors (sunshine, economics, occupation, dental study and control groups) being essentially same. One factor, different in groups, was water supply, that of first-mentioned groups contg. 1 or more ppm. F; that of last group contg. 0.5 or less ppm. F. 9 refs.—*C.A.*

Is Fluorine a Therapeutic Agent for Dental Caries? HAROLD C. HODGE. J. Am. Dental Assn. **29**: 2063 ('42). Teeth of children whose drinking water contains 1–2 ppm. F, show ½ to ⅓ less caries than occurs in children drinking F-free water. Exptl. caries in rats materially decreased by fluorides in ration or drinking water. Sound enamel from non-carious teeth contains more F than does sound enamel from carious teeth. Fluorides inhibit production of acid by oral bacteria and decrease soly. of enamel and dentine in acids. Safe level of oral F administration for production of max. decrease in caries incidence not known. While ingestion of F in excess of permissible max. produces mottled enamel in developing teeth, it cannot produce this dystrophy in fully formed, erupted teeth. No signif. toxic symptoms occur in children whose drinking water contains 1 ppm. F. 10 refs.—*C.A.*

The Nutrition-Dental Caries Fellowship at Mellon Institute (III). [G. J. Cox] Chem. & Eng. News **21**: 363 (Mar. 25, '43). Fellowship, sustained for 5 yr. from Apr. '35, re-

ceived $60,000 grants to study relation of nutrition to dental caries. Demonstrated with rats, diet during formation of teeth important factor in caries resistance; signif. amts. of fluorine in diet of mother during pregnancy and lactation increased caries resistance of offspring. 67% germentable carbohydrate rations do not initiate decay in rats, but sugars accelerate development of caries if preexistent.—*A. A. Hirsch.*

Domestic Water and Dental Caries. (Parts I–IV *abstracted* Jour. A.W.W.A. **34:** 1282 ('42).) V. *Additional Studies of the Relation of Fluoride Domestic Waters to Dental Caries Experience in 4,425 White Children, Age 12 to 14 Years, of 13 Cities in 14 States.* H. TRENDLEY DEAN & ELIAS ELVOVE. U.S. Pub. Health Rpts. **57:** 1155 (Aug. 7, '42). Intensity of dental caries (d.c.), as evidenced by observation, reflects striking differences among children of different cities. Study embraced 7257 white urban school children, age 12 to 14 yr., of 21 cities. In aggregate, apparently of largely comparable circumstances and groups examd. relatively equitable re sex ratio. Studied groups limited to children *continuously exposed throughout life to variable investigated* (common water supply). Clinical examns. in all 21 cities made by same 2 dental officers and in each city, equal no. examd. by each. Seems unlikely such marked differences in d.c. prevalence explainable on basis of domestic water hardness, hr. of sunshine, or gross dissimilarities in diet (water excluded). Observed gen. inverse correlation between fluoride (F) concns. of pub. water supplies in 21 cities studied and amt. of d.c. Differences in latter experience rates as much as 2 and 3 times observed minimal, not unusual. Highest, 1037, at Michigan City, Ind., 4.4 times that observed in Galesburg, Ill., with 236, lowest rate. Strikingly low d.c. prevalence associated with continuous use of domestic waters with F content as low as 1 ppm., producing only sporadic mild dental fluorosis of no practical esthetic significance. Marked differences observed as to: (1) amt. of d.c. experience in proximal surfaces of 4 superior permanent incisors and (2) first permanent molar mortality rates. Of 4425 children in 13 cities reported, 2859, in communities whose pub. water supply contained less than 0.5 ppm. F, showed 19 times as much proximal surface caries experience in 4 permanent incisors as observed in 1566 children in cities where common water supplies had 0.6 to 2.6 ppm. F. In same 2 groups, first permanent molar mortality rate, for those affected by supply contg. less than 0.5 ppm. F, about 4 times as high as that in children subjected to greater than 0.5 ppm. F. Inasmuch as group with higher first permanent molar mortality rate showed 38% of total first permanent molar caries experience rate with fillings, as opposed to only 26% in group of lower mortality rate, justifiable to assume such differences considerably influenced by variation in d.c. attack intensity and/or teeth resistance thereto.—*Ralph E. Noble.*

Dental Caries in the Panama Canal Zone. R. W. CHAPIN & C. A. MILLS. J. Dental Res. **21:** 1: 55 ('42). Problems raised in report as to condition of teeth of children living in Canal Zone are old ones of effect of food, climate and water supply. While native Panamanians not free from dental caries, like Negroes of U.S., they show somewhat lower incidence than Americans born in Canal Zone. Reports of U.S.P.H.S. survey of temperate dist. from which families derived deal only with the 12–14 age group; authors of report, for sake of comparison, confined their attention to same age group and show that incidence of caries among immigrant Americans rises with years of residence from 5.83 boys and 6.48 girls of less than 1 yr. residence to 7.06 boys and 7.49 girls after 6-yr. residence. Figures do not, however, reach no. of carious teeth per mouth of those American children born in Zone, which is 7.45 boys and 8.25 girls. Native Panamanians of same ages show 7.04 boys and 7.28 girls. Would seem that, owing to care and attention to health bestowed by authorities on Zone, health conditions there are as good as those of the dist. of U.S. from which Am. residents have migrated; all food imported from home except fresh green vegetables and fruit. Ample milk supply from imported cows fed on imported foods mixed according to scientific formulas. Dist. freed from parasites and other sources of infection. Only difference between Americans and Panamanian native children lies in food, natives eating their own products. Meat imported from U.S. has no deficiency of vitamin B complex, factor in native fed meats. Suggestions that condition arises as result of soft water, but more from heat, which is excessive and cause of debility. Something of same kind reported from other parts of the world, such as Ceylon and Honolulu.—*B.H.*

BACTERIOLOGY

A Simple Procedure for the Recovery of Agar. GEORGE P. BLUNDELL. Science **97:** 76 (Jan. 15, '43). Discarded culture media contg. agar kept in waste pans separate from liq. media, autoclaved as usual to sterilize, filtered through cheesecloth to remove coagulated proteins, i.e., blood and serum, poured into refrigerator trays to cool, then trays placed in freezing compartment overnight. Following morning, frozen material rapidly melted in warm alc. Aq. alc. contg. agar particles filtered with cheesecloth instead of paper to speed filtration. Agar thus collected repeatedly washed with distd. water. Dehydration accomplished by washing with alc. Following wash with water, corners of cheesecloth gathered up to form sack and latter immersed in 95% alc. and compressed to remove water. Shreds thus obtained spread out in porcelain evapg. dish and dried in 37°C. incubator. Such recovered agar as satisfactory as fresh commercial agar. Quant. depends on care in handling.—*Ralph E. Noble.*

Reclamation of Agar. HILDA G. MACMORINE. Can. Pub. Health J. **33:** 461 (Sept. '42) (*cf.* Jour. A.W.W.A., **34:** 620 ('42)). Use of acetone as pptg. agent avoided by concg. by freezing and thawing. Any blood or serum present removed by coagulation with heat and straining through cheesecloth and, if agar strength less than 2.5–3.0%, it is concd., after sterilization by autoclaving, by freezing 15–20 l. in single block and draining in cheesecloth. About 60% of water-soluble constituents removed in this manner, leaving thick gel contg. about 4% agar. Draining facilitated by breaking with icepick after exposing to atm. temp. for 3–4 hr. Gel melted in double-boiler, poured into 2-l. glass cylinder, 5" in diam., allowed to set, cut into slices 0.5 cm. or less thick and washed in cold tap water to remove addnl. water-soluble constituents. This requires 2 days and about 6 changes of water. Agar slices then drained in cheesecloth-lined funnel, melted in double-boiler and dild. to agar concn. of 1.5%. Carbon black then added in proportion of 3 teaspoonfuls per l. After heating for ½ hr., soln. filtered through mat of hot paper pulp (mascerated Seitz films) contained between 2 sheets of filter paper in Büchner funnel. Clear soln., which is about same color as soln. of commercial agar, frozen and drained as before and resulting gel spread in shreds, made by squeezing through fingers, on several thicknesses of filter paper. With aid of elec. fan and occasional turning, shreds will dry in atm. in about 2 days. Up to 90% recovery effected and product as satisfactory as commercial agar except for slight decrease in rate of soln.—*R. E. Thompson.*

Agar-Bearing Sea Weeds at La Jolla, Calif. ROBERT H. TSCHUDY & MARSTON C. SARGENT. Science **97:** 90 (Jan. 22, '43). Out of 5 red algae species not previously considered agariferous, harvestable in moderate quant. at La Jolla without special equip., 4 readily yielded agar in quant. and qual. equal to that obtained from red algae now commercially exploited. These were *Gelidium cartilageneum, Petrocladia sp., Endocladia muricata* and one other. —*Ralph E. Noble.*

A Modification of Wilson and Blair's Bismuth Sulfite Agar (Stabilized Stock Solutions). J. A. DE LOUREIRO. J. Hyg. **42:** 224 (Apr. '42). Instability due to oxidation of "stock bismuth sulfite mixture" modification of Wilson and Blair medium may be overcome by use of 3 separate clear solns. in "A.B.C. bismuth sulfite agar" now described. Agar base: 3% extract agar in 100-ml. portions, sterilized. To each add 0.4 ml. of 1% bactobrilliant green. Dye-agar may be stored for months in dark place.

Soln. A:	Bismuth citrate	12.0 g.
	Water	10.0 ml.
	Ammonia (sp.gr. 0.880)	6.4 ml.

Make paste with bismuth and water, slowly stirring till soln. clear. Then add water to 100 ml. This keeps indefinitely.

Soln. B:	Na_2SO_3 anhydrous	10.0 g.
	Na_2HPO_4 anhydrous	5.2 g.
	Water	46.0 ml.

This soln. keeps indefinitely in stoppered bottles. May crystallize, but crystals melt easily on warming.

Soln. C:	Glucose	5.0 g.
	Water	25.0 ml.

Dissolved with moderate heat. Add

	$FeSO_4$, $7H_2O$	0.4 g.

This is not entirely stable, but high concn. of glucose prevents excessively rapid oxidation. Medium prepd. by adding to 100 ml. of agar 5 ml. of soln. B and 2.5 ml. each of soln. A

and soln. C. Solns. conveniently mixed in test tube and added after few min. to melted agar. Plates effective until grayish yellow color changes to green, usually after 2 or 3 days in ice-chest.—*B.H.*

Constitution of Agar. ANON. (*Published in abstract only.*) Nature **150:** 27 (July 4, '42). In expts. by Jones and Peat (J. Chem. Soc., p. 225 ('42)) evidence indicates agar is sulfuric acid ester of linear polygalactose, unit chain composed of 9 *d*-galactose residues mutually combined by 1 : 3-glycosidic linkages and terminating at reducing end by residue of *l*-galactose, united with rest of chain by glycosidic linkage engaging C_4, not C_3. The *l*-galactose member is esterified at C_6 with H_2SO_4. Suggested that in biol. synthesis, SO_4 fulfills similar function to PO_4 in enzymatic synthesis of starch from glucose *l*-phosphate. Phosphoric acid not retained in starch, but with the agar. The H_2SO_4, functioning as *d*-galactose *l*-sulfate, remains with an adjusted orientation as integral part of molecule.—*Ralph E. Noble.*

Counts on Bromthymol Blue Lactose Agar for Determining the Potability of Drinking Water. W. LORENZ. Ztschr. für Hyg. Infekt. (Ger.) **123:** 576 (Mar. 16, '42). Author shows that counts of yellow colonies on bromthymol blue lactose nutrient agar at 37°C. useful indicators of potability of well water. Most well waters of good repute showed no colonies on this medium. Count of more than 10 per ml. indicated insufficient purif. of water in ground.—*B.H.*

Utilization of 21 Proprietary Peptones by Representative Aerobic and Facultative Bacteria. MARGARET MCMASTER & CARL E. GEORGI. (*Published in abstract only.*) J. Bact. **44:** 391 (Sept. '42; issued Nov. 1, '42). Quantitatively, peptones vary much in supporting growth of test organisms. Support vigorous with 0.1, 0.01, 0.001% concns. in semi-solid glucose peptone agar. All but one contained sufficient compds. with guanidine nucleus to give good acetyl-methyl-carbinol test. 5 superior for indole test; 3 failed. Of 3 indicator ions, Fe, Pb and Bi, for detecting H_2S production, Bi most satisfactory with various peptones, 4 yielding good results. Indicator used for purpose must be considered when suitable peptone being chosen. 3 peptones unsuitable for H_2S demonstration with any ions used.—*Ralph E. Noble.*

The Copper Content of Commercial Peptones. HENRY H. BALCH. J. Path. & Bact. **54:** 377 ('42). Some reduction in Cu content of commercial peptones since report of O'Meara and Macsween. Some mfrs. have as yet failed to remove Cu in sufficient deg. to make them non-inhibitory to bact. growth. Ni may occur as metallic contaminant of peptone, but appears to have no growth-inhibiting action.—*C.A.*

Preparation of Deoxycholic Acid. G. A. D. HASLEWOOD. Nature **150:** 211 (Aug. 15, '42). Problem of obtaining deoxycholic acid (3,12-dihydroxy cholanic acid) acute. Isolation from bile laborious and yields uncertain. As acid now widely used in bact. media, prepn. from cholic acid (from bile) successfully undertaken. Cholic acid (3,7,12-trihydroxy cholanic acid) directly oxidized by cromium trioxide under controlled conditions to mixture giving semi-carbazone, mp. 250°, of 7-keto, 3,12-dihydroxy cholanic acid of high purity, identified by chem.-phys. properties and oxidized to well-known dehydro-deoxycholic acid (3,12-diketo cholanic acid).—*Ralph E. Noble.*

Detergents and Staining of Bacteria. S. F. SNIESZKO. Science **96:** 589 (Dec. 25, '42). To obtain satisfactory microscopic prepn. of bacteria with cells uniformly distributed, necessary to clean slides thoroughly by chemicals, by flaming, or both, to elim. high surface tension caused by fat-like substances effecting uneven and massed bact. distr. Water solns. of detergents "Aerosol OT" or saline soln. of "Aerosol MA," 1 : 500, give satisfactory results used as follows: 1 loopful placed on slide. Bacteria from liq. or solid media added to drop and suspension spread uniformly over desired area with loop. Prepns. air-dried without heating, fixed with methyl alc. or heat, stained as usual. No detrimental effect of detergent on staining qual. noticed. Prepns. for staining flagella similarly satisfactory when bacteria suspended in distd. water contg. 1 : 1000 "Aerosol OT." Results still better, however, when washed and flamed slides used.—*Ralph E. Noble.*

A Simple Method for Obtaining Uniform Bacterial Suspensions. D. G. FF. EDWARD & M. VAN DEN ENDE. J. Path. & Bact. **54:** 386 (July '42). Mech. method described for breaking up chains of such organisms as streptococci into single cocci and for rendering

persistently granular bact. suspensions homogenous. Effect produced by atomization and collecting larger droplets in suitable trap. Method might be helpful in enumeration and serological typing of streptococci and titration of their pathogenicity; prepn. of vaccines.—*Ralph E. Noble.*

Bacterial Activity in Dilute Nutrient Solutions. CLAUDE E. ZOBELL & CARROLL W. GRANT. Science **96:** 189 (Aug. 21, '42). Most media designed for growing heterotrophic bacteria contain 0.1 to 1.0% org. matter. Generally claimed that min. concn. required for their multiplication, between 0.001 and 0.01%, or 10 and 100 mg./l. This considerably higher than usually found in lakes, soil solns. or sea water. Latter avgs. 4 or 5 mg./l., largely refractory to bact. decompn., yet evidence bacteria multiply and otherwise active therein. Bact. pop. may increase from few hundred per ml. of fresh sea water to several million after few days lab. incubation. To approach min. quant. of org. matter limiting bact. activity, org. matter-free mineral soln. prepd. To it peptone added to give concns. from 1.0 to 100 mg./l., after which test-tube quants. inoculated with loopful of org. matter-free water, contg. 10 to 100 living bact. cells. After thorough mixing, loopful quants. streaked on nutrient agar plates and procedure repeated at 24-hr. intervals. So few cells introduced, growth rarely occurred on plates inoculated initially. After 24-hr. incubation at 22°C., however, 10 of 12 cultures tested had multiplied enough to produce abundant growth. As controls properly neg., expt. showed cultures multiplied in most dil. peptone mineral solns., although those contg. more than 10 mg./l. of peptone were turbid. Similar results obtained in dil. glucose ammoniacal mineral solns. Not surprising that dil. nutrient solns. not cloudy with bact. growth, because it requires about a billion cells per ml. of size used to produce perceptible turbidity. Even if all org. matter (1 to 10 mg./l.) assimilated, not enough to give requisite no. to produce cloudiness. Moreover, many cells in dil. nutrient solns. grow attached to walls. Quant. results obtained by inoculating glass-stoppered bottles contg. mineral soln. treated with concns. of glucose from 0.1 to 10 mg./l. After different intervals, bact. pops. detd. by plate count procedures and D.O. content of water measured. Results showed bact. multiplied in glucose concns. as low as 0.1 mg./l. and this amt. completely assimilated in 4 or 5 days at 22°C. 10 to 20 days required for complete assimilation of glucose concns. as large as 1 to 5 mg./l. Between 60 and 70% glucose oxidized and remainder converted to bact. protoplasm. Similar results obtained with glycerol, ethanol, succinic acid and lactic acid. Solid surfaces seemed to facilitate assimilation of dil. nutrients. Under proper conditions believed concns. of less than 0.1 mg./l. will provide for bact. multiplication.—*Ralph E. Noble.*

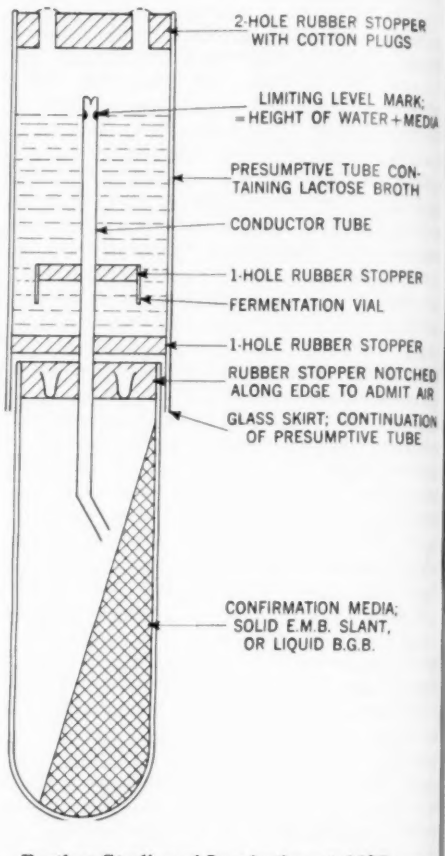
Control of Micro-organisms by Ultra-Violet Radiation. HARRY STIERLI. Agric. Eng. **23:** 262 (Aug. '42). Wavelength band of radiation, energy distr. and normal overall eff. of hot cathode and cold electrode germicidal lamps suitable for lethal action on micro-organisms. Lamp installation in air above water, or immersion directly therein, offers unfavorable operating conditions. In both cases, especially latter, low temps. necessary for pre-cooling drastically reduce ultraviolet (u-v.) output and life. Immersed operation improved by enclosing lamp in special u-v.-transmitting glass. Low temps., turbid water, oil films and dirt on immersed lamp markedly reduce killing action. Under certain conditions, u-v. reflector improves eff. Commercial hydro-coolers tested using large no. of hot cathode and cold electrode germicidal lamps with both methods of placement. Satisfactory micro-organism control not obtained. At this time, therefore, seems impractical to use u-v. radiation for this purpose in pre-cooling waters because too many lamps required to produce sufficient intensity.—*Ralph E. Noble.*

Effect of a Vacuum on Destruction of Bacteria by Germicides. A. J. SALLE & M. KORZENOVSKY. Proc. Soc. Exptl. Biol. & Med. **50:** 12 (May '42). Bact. destruction by germicides unaffected whether organisms mixed with germicidal dilns. in presence or absence of vacuum. Results entirely different with gaseous germicides. Vacuum increased eff. under certain conditions; not destroyed without it. Increased germicidal eff. of formaldehyde, chiefly a surface disinfectant, under vacuum more likely due to increased penetration of gas thereby. Vacuum principle produces deep penetration of gas into porous material. Method efficient, cheap, easily performed and indispensible for sterilizing objects subject to injury by dry or moist heat.—*Ralph E. Noble.*

A Study of Certain Factors Which Influence the Apparent Heat Resistance of Bacteria. F. E. NELSON. (*Published in abstract only.*) J. Bact. **44:** 389 (Sept. '42; issued Nov. 1, '42). Studied quant. effects of different plating media, temp. variations and incubation periods upon enumeration of heat-treated bacteria: *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus liquefaciens* and *Streptococcus zymogenes*. Within fairly wide limits of variation, factors studied had little or no effect upon unheated broth culture counts. Incubation at 32°C. usually gave higher counts than 21°, 28°, 37° or 42°C. 96-hr. counts appreciably higher than 48-hr., especially at lower incubation temps. Heated bact. much more sensitive to pH of recovery medium than controls. As little as 0.00021% thioglycollic acid usually produced considerable plate count increases of heat-treated bact., while larger amts. had still greater effect up to limit functioned by medium and organism. Cysteine gave similar effect. Suitable plating procedures exert considerable differences in apparent no. of survivors.—*Ralph E. Noble.*

The Bacteriological Examination of Water Samples With Reference to Direct and Secondary Incubation at 44°. L. F. L. CLEGG. J. Path. & Bact. **53:** 51 ('41). Temp. of 44° frequently not as suitable for growth and acid and gas production by *Esch. coli* in MacConkey broth as 37°. Larger inocula required to induce growth at 44°. Good method for water examn. to incubate MacConkey broth tubes at 37° for 48 hr. and subculture pos. tubes in citrate media for 48 hr. at 37° and MacConkey broth tubes at 44° for 48 hr. For best results, well to incubate 1 primary set of MacConkey broth at 37° and one set at 44°, and subculture all pos. tubes in citrate at 37° for 48 hr.—*C.A.*

The Examination of Contaminated Waters. H. L. FRUITMAN. Science **94**: 119 (Aug. 1, '41). Rapid method to detect presence of *Esch. coli* in vol. of water in 8 to 10 hr. instead of normal 48 to 96 hr. described and illustrated. Principle of method is utilization of gas produced by fermentation in presumptive medium to cause small amt. of enriched inoculum to overflow into conductor tube and automatically inoculate confirmatory medium. Speed of process depends on rate of gas production, which itself depends on factors such as type of coliform organism present, frequency of lactose fermenters in sample vol., size of fermentation vial and conducting tube, etc. 4 hr. found optimal time before fluid should pass into conductor tube; diagram (immediately following) illustrates main features of apparatus.—*B.H.*


2-HOLE RUBBER STOPPER WITH COTTON PLUGS
LIMITING LEVEL MARK; = HEIGHT OF WATER + MEDIA
PRESUMPTIVE TUBE CONTAINING LACTOSE BROTH
CONDUCTOR TUBE
1-HOLE RUBBER STOPPER
FERMENTATION VIAL
1-HOLE RUBBER STOPPER
RUBBER STOPPER NOTCHED ALONG EDGE TO ADMIT AIR
GLASS SKIRT; CONTINUATION OF PRESUMPTIVE TUBE
CONFIRMATION MEDIA; SOLID E.M.B. SLANT, OR LIQUID B.G.B.

Further Studies of Incubation at 44°C. as a Test for "Fecal Coli." H. P. SHERWOOD & L. F. L. CLEGG. J. Hyg. (Br.) **42:** 45 (Jan. '42). Authors define "fecal coli" as cultures having reactions indole-pos., methyl-red-pos., V-P.-neg., citrate-neg., regardless of their reaction in MacConkey broth at 44°C. 160 cultures examd. from shellfish, sewage, feces of man, sea birds, a sheep and a cow. *Esch. coli* type I well represented in all samples, varying from about 25% in mussels to 100% in five samples of feces. In sixth sample of feces of human origin 39% *Esch. coli* type I, 16% *Esch. coli* type II and 45% intermediate

type I. Close association between 44°C. positives and pos. indole, pos. methyl red, V-P.-neg., citrate-neg. types (++−− "IMViC" types). Incubation at 44°C. proved to be almost exact procedure for ascertaining total no. of ++−− lactose fermenters, the comparatively few ++−− cultures which gave neg. result at 44°C. being numerically balanced by presence of 44°C. pos. irregular types II and VI. All cultures examd. at incubation temps. varying from 37°C. to 46°C. Rise in temperature from 37°C. to 44°C. had little effect on ++−− cultures, only 2.7% being cut out, but above 44°C. effect so great that further 75% cut out. Other coliform types much reduced between 37°C. and 41°C. and at 46°C. hardly any survived. Temp. of 44°C., using MacConkey broth, seems most suitable for permitting max. no. *Esch. coli* to produce gas while inbibiting max. no. of other coliform organisms. Frequency of coliform flora of shellfish samples closely resembled that found in sewage samples, but presence of citrate-utilizing lactose fermenters among high proportion of *Esch. coli* of little practical importance. Again, known that coliform organisms other than *Esch. coli* capable of multiplying on shellfish. Method of detection of *Esch. coli* by 44°C. test particularly suitable for shellfish, where detection of other coliform organisms appears to serve little, if any, useful purpose.—*B.H.*

Confirmations of the Coliform Group From Raw and Chlorinated Waters With Brilliant-Green Bile Lactose Broth. ELSIE WATTIE. J. Bact. (*Published in abstract only.*) **45:** 44 (Jan. '43); Pub. Health Rpts. **58:** 377 (Mar. 5 '43). Coliform detns. made on 228 pold. surface water samples and 717 representative ones of same raw water after chlorination alone. Pos. presumptive lactose broth tubes confirmed by transfer to B.G.B. and confirmed results critically compared with those of completed test. Using any amt. of gas production in 48-hr. incubation as criterion for confirmed result in B.G.B., M.P.N.'s from raw water samples identical with those of completed test in 79.8% of samples. M.P.N.'s from B.G.B. higher in 15.4% while those from completed test higher in 5.4%. For this group, 25% of pos. results by B.G.B. obtained after 24 hr. of incubation. Using same criterion for the 717 chlorinated samples, results identical in 96.3%, while those from B.G.B. higher in 2.8%, and from completed test, higher in 0.9%.—*Ralph E. Noble.*

A Simple Method for the Count of Viable Bacteria in Water. K. STUNDL. Zent. f. Bakt. **147:** 4: 267 (July 7, '41). Gelatin medium for total viable counts does not represent natural living-ground for bacteria. Presence of organisms that liquefy gelatin often makes counts impossible and does not give slower growing organisms chance to show themselves. Further mistaken assumption that each colony grows from one cell only—while this rarely the case save possibly in purest of waters. Author outlines various diln. methods recommended from time to time and puts forward simplified method, process of which is as follows:

Dilution 1—1 ml. of sample into 99 ml. sterile water. Shake thoroughly.

Dilution 2 (if necessary)—1 ml. of diln. 1 into 99 ml. sterile water. Shake thoroughly.

If necessary, make another diln. (Dilution 3) in same way.

Inoculate 2 ml., 1 ml., 0.2 ml. and 0.1 ml. quants. of above dilns. into tubes of 10 ml. sterile 0.2% peptone water and incubate. From smallest vol. showing growth, approx. figure for bacterial content of water can be calcd. With 8 tubes, counts ranging from 100 to 500,000 per ml. may be made. Margin of error wide, but method useful for comparative purposes. Author made parallel tests with gelatin in various types of water and found peptone water method to give consistently higher figures. Diln. method less accurate than Krombholz method used for enumeration of coliform organisms (decimal dilns. with 10 tubes set up for each vol.) but requires fewer tubes. Method used for study of sulfur and nitrogen cycles, bacteria of which do not grow readily on gelatin and agar, also for pure culture work, on assumption that growth in end-point tube originated from single bacterial cell.—*B.H.*

Multiplication of Bacteria in Water and Its Significance in Food Spoilage. C. H. CASTELL & L. A. MCDERMOTT. Food Research **7:** 244 ('42). When water from deep and shallow wells, having initially low bact. counts, enclosed in container in air, extensive multiplication takes place. Types of bacteria encountered are mainly of general *Alcaligenes*, *Pseudomonas* and *Achromobacter*. Large no. are lipolytic, proteolytic and oxidase-pos. and many are active at very low temps. That such micro-organisms are injurious to fish, butter and other nonacid protein or fatty foods seems self-evident. Initial concns. of

1.0 ppm. of Cl markedly reduced nos. of bacteria in water and no evidence of after-growth after period of 120 hr. Lower initial concns. of Cl, 0.12 to 0.37 ppm., effected temporary decrease or lag in growth followed by rate of increase which was greater than in unchlorinated control. Growth of bacteria in water of low org. content restricted to certain groups of Gram-neg. bacteria. Known species of *Pseudomonas* particularly active in water.—*C.A.*

Potassium in Bacterial Fermentation. J. LEIBOWITZ & N. KUPERMINTZ. Nature **150:** 233 (Aug. 22, '42). Verzar and Pulver (Nature **145:** 823 ('40)) discovered alc. fermentation by yeast cells accompanied by striking equilib. shift between extra- and intracellular K. Beginning fermentation marked by vigourous K intake; later liberated from cells. Phenomenon unexplained. Appears "K-effect" gen. feature of glycolytic processes. Authors demonstrated same thing in desmolysis of glucose, maltose, to lactic acid, H, etc., by *Esch. coli*. Suspension of latter in *M*/60 glucose, *M*/250 KCl, *M*/30 (Na_2PO_4-Na_2HPO_4), pH 7.05, incubated at 41°. Glucose and K detd. in samples drawn from soln. and cleared by centrifuging. As to intrinsic nature of relation between "K-effect" and sugar metabolism: (1) no such effect occurs when fermentable sugar omitted from phos.-KCl medium; (2) temp., pH, substrate concn., aerobiosis or anaerobiosis exert parallel influence on fermentation rate and K absorption. Conversion of sugar into polysaccharide in initial stage of sugar demolysis established by authors for bact. fermentation.—*Ralph E. Noble.*

Observations on the Preparation and Testing of Antigenic Fractions From *Eberthella typhosa*. J. UNGAR, R. M. JENNER & R. F. HUNWICKE. J. Path. & Bact. **54:** 331 (July '42). Essential to use motile smooth virulent strains of *Eberthella typhosa* for prepg. antigenic fractions. Strains specifically designated "Vi" proved inferior for purpose. Different killing agents alter antigenic compn. of bact. cells in different ways. Phenol, merthiolate and chloroform all kill in short period, causing least alteration in immunologic constitution. Bacteria in suspension liberate considerable proportion of antigens into supernatent fluid, but occurring to less deg. with merthiolate. Microscopic agglutination, using living suspensions, simple and reliable test of acquired immunity in mice, enabling differentiation between various antigens. Complement fixation and precipitin tests less reliable. Mice immunized with antigen of high serological response always show full protection against 10 times lethal dose of homologous organism.—*Ralph E. Noble.*

Bacterial Reduction of Tetrathionate. M. R. POLLOCK, R. KNOX & P. G. H. GELL. Nature **150:** 94 (July 18, '42). In attempts to improve selective media for isolating Salmonellas and *Eberthella typhosa* from excreta, authors found, in case of some organisms, tetrathionate (tetra.) first reduced to thiosulfate (thio.) rapidly and quantitatively. Ests. at different stages show molecular concn. of thio. formed twice that of tetra. disappeared, thus: $Na_2S_4O_6 + 2H \rightarrow Na_2S_2O_3 + H_2S_2O_3$. Subsequent further thio. reduction to H_2S so slow that tetra. reduction followed rapidly by direct iodometric thio. titration, provided high acidity from thiosulfuric acid controlled by phos. buffer. Ability to reduce tetra. possessed by most Salmonellas and by members of Proteus group, but not by most other fecal organisms tested, including *Esch. coli*, *Aer. aerogenes* and dysentery bacilli. Most expts. with *Salmonella schottmuelleri*. Reaction followed in growing broth cultures or with thick washed suspensions. Unless suitable H donator, mannitol, glucose, added to latter, reaction slow. When prepd. from organisms from plain nutrient agar, washed suspensions show apparent lag phase before rapid reduction of tetra. begins. Not present when agar contains tetra. Suspensions grown on plain agar can be "adapted" to reduce tetra. without initial lag-phase by incubation only 3 hr. with tetra. and mannitol without addnl. source of N. Reaction appears similar to other known types of anaerobic oxidation processes. Evidently it involves H donator, specific dehydrogenase, heat-stable co-enzyme-like factor in tryptic digest broth and acting as H carrier, a reducing enzyme mechanism and H acceptor (tetra.). "Adaptive" effect mentioned, plus fact tetra. reduction restricted to certain organisms suggests true acceptor specificity. Discovery of this system important. Shows certain facts obviously important in attempt to explain selective action of tetra. in media for isolating Salmonellas, etc. Significant that, generally, organisms actively reducing tetra., grow well in media contg. it in relatively high concns., and that, in competitive growth as in feces cultures, tetra.

selects those capable of reducing it. Furthermore, interesting that reduction product is thio., much less toxic than tetra. Provides example of oxidation mechanism similar to that present in facultative anaerobes, quite likely of value to tetra. reducers under low O_2 tension. Affords investigation of acceptor specificity and enzyme adaptivity. Simple titration technique, though limited in application, convenient for studying enzyme kinetics. —*Ralph E. Noble.*

The Ecology and Significance of the Different Types of Coliform Bacteria Found in Water. *A Review of the Literature.* C. B. TAYLOR. J. Hyg. (Br.) **42:** 23 (Jan. '42). All investigators agree that *Esch. coli* type I by far most abundant coliform type in feces of man and other warm-blooded animals, including birds, but proportion of other types less certain. By special isolation procedures on citrate media, workers able to show high proportion of I.A.C. organisms in feces. These organisms may have been ingested and survived, which would acct. for their occasional isolation from feces, but in some cases quoted, *Aer. aerogenes* exceeded *Esch. coli* in sample. Considerable changes occur in proportions of coliform types in stored feces. At first a general multiplication, most rapid at higher temps. up to 37°C. Further storage leads to decrease in all types with *Esch. coli* dying off more rapidly than other coliform types. Sunlight appears to hasten decrease. *Aer. aerogenes* and intermediates dominant coliform types in urine from genito-urinary infections. Enormous numbers of lactose fermenters may be found on grasses and grains if temp. of 30°C. used for isolation, while at 37°C. very few can be detected. Types capable of developing at 30°C. and not at 37°C. not coliform organisms, but belong to other genera, notably *Erwinia*, genus contg. many plant pathogens. Samples of decaying straw, hay, grass, leaves, etc., by nature of their habitat, have been in contact with soil, possibly manured, and give relative preponderance of *Esch. coli* types; while in grains, meals and feeding cakes, representing material long since in contact with soil, *aerogenes-cloacae* types predominant. Examples given of multiplication of coliform types in silage. Multiplication of coliform organisms other than *Esch. coli* common occurrence in many phases of water works practice. Almost impossible to state definitely that certain sample of soil free from animal poln., but soil relatively free from poln. contains only few or no coliform organisms. No evidence of multiplication of coliform bacteria in soil found and changes in soil heavily pold. by animal excreta similar to those occurring in stored feces, namely, all coliform types tend to decrease, but *Esch. coli* at greater rate than I.A.C. types. Still remains to be shown whether coliform types can multiply in decaying org. matter at temps. approxg. body heat, as in tropics. Author concludes that not, as yet, sufficient evidence to show that intermediate-*aerogenes-cloacae* types normal inhabitants of soil, grasses and grains, and, in meantime, extent of their rôle as indicators of fecal poln. should be commensurate with frequency of their isolation from excremental material.—*B.H.*

Bacteriology of Fresh Water. C. B. TAYLOR. J. Hyg. **41:** 17 ('41); **42:** 284 ('42). I. *Bacteria in Fresh Water* (*Abstracted*, Jour. A.W.W.A. **32:** 1050 ('40)). II. *Distribution and Types of Coliform Bacteria in Lakes and Streams.* Seasonal variations in no. of bacteria in Thirlmere, Windermere and Esthwaite Lakes detd. Total nos. of bacteria in streams feeding lakes increased when rain followed dry period; then fell off with continued rain, except in streams pold. with sewage, where diln. effect preponderant from start. Coliform bacteria more numerous in summer than winter. Plate counts and counts of coliform bacteria generally varied in same direction. In lakes, coliform bacteria most numerous during summer and autumn, and exhibited decided fluctuation from week to week in epilimnion. No explanation of this, but temp. may effect viability. During winter circulation, no. of bacteria approx. same at all depths, but during summer stratification no. least and fairly const. in lower stratum. This important if lower water drawn off for water supply, as any bact. poln., by remaining in upper layer, might pass undetected until winter. 70% of total no. of organisms producing acid and gas from lactose at 37° were *Esch. coli* types I and II, but percentage ranged from 98 *Esch. coli* type I in purest to 37 in polluted waters, difference being due to greater no. of *Aer. aerogenes* and intermediate types in latter. Signif. of this result discussed. 27% of total cultures isolated from pos. MacConkey tubes failed to ferment lactose at 37°, although about half fermented lactose at 30°, and most could be trained to react at 37° but not at 40°. Such organisms most frequent in pold. waters. Various non-lactose-fermenting species of

other genera found. III. *The Types of Bacteria Present in Lakes and Streams and Their Relationship to the Bacterial Flora of Soil.* Water from lakes and their inflows in Lake Dist. plated on sodium caseinate agar and incubated at 20°C. for 15 days. This medium best suited to obtain growth of largest proportion of bacteria present. Colonies from these plates studied for their staining, morphological and biochem. products. Difficulties naturally arose in that majority of organisms did not grow on subculture in ordinary nutrient media. Found that satisfactory isolation could be obtained by growth in 0.4% semi-solid sodium caseinate medium and subcultures made from this after several days' growth at 20°C. More than 800 cultures studied from lakes and streams. Most were rods, Gram-neg. and chromogenic, yellow forms predominating. Coccus forms rare and spore-bearing organisms only 10% of total. Cultures on the whole biochemically inert, fact that made classification and identification difficult. Only characteristics of real differential value were colors produced on solid media and liquefaction of gelatin. Comparison with organisms found in soil showed that Gram-pos. types in water insignif. compared with those in soil. Little pleomorphism in water organisms, whereas pleomorphic rods of genera *Mycobacterium*, *Corynebacterium* and *Bact. globiforme* Conn., characteristic of soil. When cultures grouped according to biochem. activities, no consistent differences observed between types from near surface and from near bottom of lake, nor between lake and inflow, but differences observed in samples taken from same lake on different occasions. Some of bact. forms isolated probably multiply in lake water and may include forms commonly distributed elsewhere.—*C.A.*

The Eijkman Test for Fecal Coli in the Bacteriological Examination of Water Supplies. *A Survey and Discussion of the Experimental Work From 1929 to the Present Day With a Study of 104 Water Samples and of 602 Cultures.* C. G. BATTY-SMITH. J. Hyg. (Br.) **42:** 55 (Jan. '42). Paper commences with excellent and very complete historical survey of raised incubation temps. for isolation of *Esch. coli.* Temp. of 44°C. established as optimum temp. Lactose MacConkey broth is medium now associated with test and necessity for accurately controlled temp. recognized in employment of water bath as incubator. Useful practical details given of methods employed in carrying out recognized tests for differentiation of members of *Aer. aerogenes* group. 104 water samples tested by direct inoculation into two series of MacConkey broth and incubated at 37°C. and 44°C. Incubation continued for 48 hr.; then tubes examd. for acid and gas production. Tubes contg. smallest vol. pos. in each series plated out and colonies picked from plates and identified by differential tests. *Esch. coli* isolated from 68 of 104 samples and direct 44°C. method detected organism in 13 cases in which not detected at 37°C.; on other hand, 37°C. method successful in nine samples at expense of the 44°C. method. [Not clear whether corresponding vols., pos. at 44°C. and 37°C., plated out and various colonies examd. For accurate comparison of two incubating temps., such procedure should have been adopted, or, better still, *all* presumptives should have been plated.] Tables giving collected results of other workers with regard to specificity of 44°C. MacConkey test indicate that false positives at 44°C. negligible for all practical purposes as far as this country concerned. Concluded that best all-round method for estn. of *Esch. coli* content of water is by Wilson's method No. IV (primary incubation of water sample vols. at 37°C. and subculture of positives into MacConkey and incubation at 44°C.) Incubation period of 48 hr. to be preferred, but 24 hr. sufficient where rapidity desired.—*B.H.*

An Examination of the Modified Eijkman Method Applied to Pure Coliform Cultures Obtained From Waters in Singapore. G. E. BOIZOT. J. Hyg. (Br.) **41:** 566 ('41). Coliform organisms can be divided into 2 main groups: fecal coli, of which *Esch. coli* type I considered typical, and non-fecal organisms comprising intermediate-*aerogenes-cloacae* organisms. In temperate climates found that practically every strain forming gas in MacConkey broth at 44°C. belongs to fecal *Esch. coli* type I group. In tropical countries test proved not so successful; may be due to higher incidence of intermediate-*aerogenes-cloacae* organisms in tropical waters or to higher resistance to heat acquired by the organisms in waters. Tests made on waters in Singapore where avg. temp. 80°F. and incidence of intermediate-*aerogenes-cloacae* organisms in natural waters high. 61 samples of water from wells, reservoirs, etc. examd. and 125 different coliform organisms isolated in pure culture and examd. after incubation in MacConkey

broth at 44°C. Results given in table. In 9.6% of samples not contg. *Esch. coli* type I, test gave pos. result. 13.3% cultures of *Aer. aerogenes* type I gave pos. reactions, as compared with 0.7% in England, and 63.3% in India. Concluded that test in MacConkey broth at 44° cannot be considered specific for fecal *Esch. coli* type I in India and Malaya, and can be used for differentiating coliform organisms into fecal and non-fecal types only if *aerogenes*-like organism growing at 44°C. a normal intestinal organism and not a non-fecal organism which, owing to higher temp., has acquired a resistance to heat.—*W.P.R.*

The *Erwinia*-Coliform Relationship. R. P. ELROD. J. Bact. **44:** 443 (Oct. '42). *Erwinia*, genus of bact. plant pathogens, closely related to *Escherichia-Aerobacter* group. Manner of lactose fermentation by *Erwinia* species tends to classify them as aberrant coliform organisms. On basis of "IMViC" patterns, majority approx. *Esch. freundii*. According to gelatin-liquefying ability, motility and acid production in glycerol, however, relationship seems closer to *Aer. cloacae*. 16 *Erwinia* cultures macerated vegetable tissue, characteristic not shared by 50 coliform cultures. All but 2 *Erwinia* isolated fermented pectin in synthetic medium while 22 of 50 coliform organisms, including 3 fecal *Esch.*, did so. No correlation between plant tissue disorganizing ability and pectin fermentation. On basis of macerating ability, contended placing of soft-rot organisms in genus (*Erwinia*) separate from coliforms valid. At same time, close relationship of 2 groups recognized.—*Ralph E. Noble.*

Differentiation of the "Intermediate" Coli-like Bacteria. REESE H. VAUGHN & MAX LEVINE. J. Bact. **44:** 487 (Oct. '42). "Intermediate" cultures collected and studied over 10-yr. period. Group constitutes distinct section of coliform bacteria; differentiated from *Escherichia* and *Aerobacter*. Section differs from true *Esch.* in that former: (1) utilizes citrate radical as sole C source in otherwise inorg. medium; (2) produces H_2S in proteose peptone, ferric citrate agar; (3) decomposes cellibiose; (4) uses urea as sole N source, but does not use uracil; (5) does not grow well at 45°–46°C. (Eijkman); (6) not resistant to boric acid. Differentiated from true *Aer.* in that intermediate section: (1) does not produce acetylmethylcarbinol from glucose (V.-P.); (2) methyl-red pos.; (3) generally produces H_2S in proteose peptone, ferric citrate agar; (4) does not utilize uric acid, uracil, yeast nucleic acid, allantoin or hydantoin as sole N sources, but does use urea; (5) does not decompose sodium malonate. Intermediate coli-like bacteria markedly group-specific in reaction to bacteriophages and metabolites from staled agar. Most closely related to genus *Esch.* through physiol. similarity in glucose metabolism. Cultures studied thus allocated to genus *Esch.*, stressing, however, that until natural habitat of section proved more conclusively, desirable to segregate such cultures from true *Esch. coli* predominant in feces of vertebrates. On basis of statistical correlation, 2 species of intermediate coli-like bacteria recognized. Predominant species, *Esch. freundii*, represented by 196 cultures. Remaining 27 described as *Esch. intermedium nov. comb.* New description of *Esch. intermedium* given.—*Ralph E. Noble.*

Fixation of CO_2 by a Cell-Free Extract of *Escherichia coli*. GEORGE KALNITSKY & C. H. WERKMAN. (*Published in abstract only.*) J. Bact. **44:** 256 (Aug. '42). Active, cell-free enzyme prepn. obtained from *Esch. coli* by grinding organisms with powd. glass and extracting with phosphate buffer. Pyruvate dissimilated anaerobically to acetic, formic and succinic acids, CO_2 and lactic acid trace. No H formed. Reaction proceeds in pH range 6.4 to 7.0; optimum at 6.8. Prepn. contains strong formic dehydrogenase and hydrogenase activity as detd. by methylene-blue reduction. Oxalacetate and fumarate reduced in atmosphere of H. No hydrogenalase activity. In atmosphere of 10% CO_2 in H_2 with bicarbonate present, CO_2 fixed, and succinate formed in amt. corresponding quantitatively to CO_2 uptake. $C^{13}O_2$ fixed in formic and succinic acids. Amt. of C^{13} in former suggests most formed from C of pyruvic acid; not by CO_2 reduction. Succinic acid formation from pyruvate and CO_2 with C^{13} in carboxyl groups particularly interesting because shows CO_2 fixation obtainable with formation of a C to C linkage with cell-free enzyme system. This offers opportunity for isolating enzyme concerned.—*Ralph E. Noble.*

The Isolation of Intestinal Pathogens by Selective Media. M. HYNES. J. Path. & Bact. **54:** 193 (Apr. '42). No. of new media for isolation of intestinal pathogens recently described. In this investigation adequate

nos. of fecal specimens from various intestinal infections cultured and results compared with one another and with direct plating on MacConkey medium which contained 0.5% lactose and 0.5% sucrose. In general, new methods gave 2 to 5 times no. of positive results. Media used were: (1) Wilson & Blair Difco dried medium (W.B.); (2) Desoxycholate-citrate (D-C), modification of Leifson's formula suggested by that of the Bacto S.S. agar medium; (3) Brilliant-green-broth in single diln. of 1/150,000; (4) Ruys' medium, consisting of 2% Esbach reagent in 1/100,000 brilliant green; (5) Tetrathionate broth. Of last three enrichment media, tetrathionate broth only one effective for *Eberthella typhosa* is best for *Salmonella schottmuelleri* and equal of others for other *Salmonellas*. It grows Proteus, however, organism which is inhibited by Ruys' medium. *Flexner Dysentery:* D-C superior to MacConkey in first few days of disease, and vastly superior after first week. *Sonne Dysentery:* D-C inhibits rough colonies but value of medium not impaired thereby. D-C grew organism twice as often in first three days, more than three times as often after first week. Confirmed that rectal swab gives better results than examn. of feces, but difference not apparent if D-C used. Rectal swab also found to be not inferior to feces examn. for investigating other intestinal infections. *Paratyphoid B:* W.B. very efficient in first 2–3 wk. of illness, but thereafter enrichment media best. D-C as good as W.B. in early weeks, but not quite so good later. For opt. results Ruys' medium and tetrathionate broth should both be used for enrichment, subculturing from these to W.B. or D-C. *Typhoid Fever:* 4 times no. of isolations made on W.B. as on MacConkey. Addnl. 15% obtained by using tetrathionate broth and subculture on W.B. D-C, either direct or for subculture, not as good as W.B. *Salmonella Infections:* W.B. and D-C much superior to MacConkey for direct plating, and further considerable no. of pos. results obtained by enrichment in any of fluid media with subsequent plating on MacConkey, W.B. or D-C, figures being slightly in favor of D-C.—*B.H.*

The Isolation of *Salmonella schottmuelleri* From Feces. K. E. Cooper, N. Wood, E. Elliot, M. Caswell & W. Small. J. Path. & Bact. **54:** 345 (July '42). In Bristol epidemic, '41, method of isolating *Salmonella schottmuelleri* with tetrathionate broth very eff. in early and late weeks of illness, but failed seriously from third to fifth week after symptoms onset. Plating feces on Wilson & Blair medium, though usually less eff. than tetrathionate method, superior to it during third and fifth week. Probably more eff. in isolating paratyphoid from highly pold. material like sewage, where organisms other than *Esch. coli* abound. Relative merits of brilliant green and tetrathionate concn. methods undecided until comparison made at all periods of illness. During early weeks, tetrathionate broth had certain advantages. Until latter's failure in middle period of typhoid illness overcome, direct plating on special solid media should be made, with tetrathionate concn. if examn. of feces relied upon for diagnosis. Action of liq. and solid media differs in principle. Method of choice depends upon circumstances of examn.—*Ralph E. Noble.*

Two New *Salmonella* Types With Undescribed Flagellar Antigens. D. W. Bruner & P. R. Edwards. Proc. Soc. Exptl. Biol. & Med. **50:** 174 (May '42). Two new *Salmonella* types with undescribed flagellar antigens reported. *Salmonella tennessee* represented by antigenic formula VI, VII : Z_{33}. Antigens of *Salmonella simsbury* characterized as I, III, XIX : Z_{27}. Each type represented by single strain from feces of normal human carriers.—*Ralph E. Noble.*

The Dysentery Bacilli. Anon. Lancet (Br.) **243:** 313 (Sept. 12, '42). Bacillary dysentery caused by any one of non-motile Gram-neg. group, principal members being Shiga, Schmitz, Sonne and Flexner. First 2 differentiated from others by failure to ferment mannitol; Schmitz from Shiga by indole production. First 2, rare causes of dysentery. First 3, single antigenic entities. Flexner, antigenic family; members have own specific antigen, but share common group antigen. Boyd found by repeated test-tube culturing, specific antigen tends to disappear, leaving group antigen behind. Newcastle bacillus, endemic in certain parts of England, differs from Flexner family in not producing indole, usually fermenting dulcitol and glucose with slight gas formation. Br. Army Med. Service adopted new, simplified nomenclature (Boyd) of *B.* [*Shigella*] *dysenteriae* Flexner I–VI, consisting of Flexner V, W, Z, 103, P119 and Newcastle. In India, Boyd also isolated antigenically distinct maitol-fermenting dysentery bacilli lacking Flexner group antigen, suggest-

ing name *B.* [*Shigella*] *dysenteriae* Boyd I, II, III, etc. Desoxycholate-citrate agar facilitates isolation and identification of dysentery bacilli when greatly outnumbered by coliform organisms as in convalescent or contact carriers, or non-fresh feces. Sonne types survive in feces or moist rectal swab several days at 15° to 20°C. Similar viability established for Flexner. Heavy growth on desoxycholate-citrate agar facilitates direct slide-agglutination with appropriate antisera. Few Sonne or Flexner strains fail this way. Now possible to diagnose bacillary dysentery with nearly 100% accuracy in 18–24 hr. after receiving specimen.—*Ralph E. Noble.*

The Genus *Shigella* (Dysentery Bacilli and Allied Species). ERWIN NETER. Bact. Rev. **6:** 1 (Mar. '42). Author discusses group as whole, then 18 species comprising 4 subgroups according to differential sugar reactions. Following general considerations developed: Many species of genus *Shigella* studied thoroughly in past, giving much gen. bact. and immunological information. Evident from review, however, that other species now classified as members of genus, not adequately investigated and little known re cultural characters, biochem. activities and antigenic structure. Safe to assume some do not belong to genus. Highly desirable to collect and study many strains of little known species of *S. septicaemiae, S. minutissiam, S. pfaffiii, S. rettgeri,* and others. Only then possible to reconsider their taxonomic position, accurately identify strains isolated from various sources, and det. their signif. in diseases of man and animal. One of most signif. recent contributions to knowledge of genus is Boyd's demonstration of group-specific antigen in certain types of *S. paradysenteriae,* possibly forming basis for similar investigation of other species and genera. His observations also practical and should be considered in any attempt to produce either active or passive immunity to infections with Flexner group of dysentery bacilli. Chem. anal. of antigenic components of some species of genus yielded interesting information during last few yr. Such investigations particularly fruitful at hands of Morgan and associates. Hoped their studies on *Shiga*'s dysentery bacillus will be extended to other species. One of least understood problems related to genus *Shigella* in particular is pathogenicity. Now, excepting *Shiga* exotoxin, very little known re factors in dysentery bacilli responsible for dysentery in man. Not explained why 1 species may cause epidemic outbreaks while closely related one does not.—*Ralph E. Noble.*

Study of Atypical Enteric Organisms of the *Shigella* Group. ELIZABETH J. COPE & KEITH KILANDER. Am. J. Pub. Health **32:** 352 (Apr. '42). Report on strains of organisms that belong to *Shigella* group, but biochemically and serologically do not fit into any of present classifications. Strains taken Feb. '39 to Aug. '41 from fecal specimens of patients with histories suggestive of previous intestinal disease. Routine procedure for examn. of fecal specimens and for cultural and other characteristics of "new" organisms described. Only apparent cultural differences between latter and organisms of *Shigella paradysenteriae* Flexner group are utilization of citrate and possible development of flagella in rough stage. Biochemically, "new" organism resembles *Shigella* group, but antigenically distinct.—*P.H.E.A.*

The Sanitary Significance of Pectin-Fermenting, Lactose-Fermenting, Gram-Negative, Non-Spore-Forming Bacteria in Water. D. B. MCFADDEN, R. H. WEAVER & M. SCHERAGO. J. Bact. **44:** 191 (Aug. '42). Studied incidence of pectin-fermenting, lactose-fermenting, gram-neg., non-spore-forming bacteria in feces of man and animal. Pectin-fermenting ability tested in extract broth and synthetic bases to which alc.-sterilized pectin added aseptically. Pectin-fermenting strains detected by acid production in synthetic medium. No visible fermentation occurred in extract broth medium. Of following strains isolated on E.M.B. agar, pectin fermented as indicated:

Strains	*Source*	*Fermented Pectin*
507	56 persons	0
68	3 horses	0
118	6 fowl	0
92	3 cows	3 from 1 cow
44	3 mules	7 from 1 mule
115	7 dogs	38 from 4 dogs

To det. incidence of pectin-fermenting coliform organisms in water, tests made with strains from colonies on E.M.B. agar plates inoculated from water samples enriched in *Std. Methods* lactose broth and pectin broth. Of 259 strains isolated, 71 fermented pectin; 35 from latter medium and 36 from former. 4 pectin-fermenting strains from water had

typical *Esch. coli* characteristics; 28 from mule and dog feces and from water, typical of *Aer. aerogenes;* 32 from cow feces and from water, characteristic of intermediate coliform organisms. Little information concerning reactions of genus *Erwinia* and non-pigmented strains of *Serratia* on coliform media. Impossible, therefore, to det. whether any pectin-fermenting organisms isolated belong to either. Concluded that as relatively more pectin-fermenting coliform organisms found in water than in animal feces, at least some not of fecal origin.—*Ralph E. Noble.*

Oxygen Demand and Oxygen Supply. OTTO RAHN & G. L. RICHARDSON. J. Bact. **41:** 246 (Feb. '41). I. *Purpose and Outline of Study:* Knowledge of O_2 consumption by bact. multiplication incomplete. Little known re utilization of energy derived from this oxidation. Definite knowledge of actual O_2 supply in so-called aerobic cultures also missing. II. *Oxygen Demand of Multiplying Bacteria:* Simple method used to measure O_2 consumed by multiplying bacteria per cell per hr. Results of more than 100 detns., in mg. O_2 per cell per hr:

Streptococci	0.5 to 2×10^{-10}
Enterobacteriaceae	3 to 5×10^{-10}
Pseudomonades	8 to 8×10^{-10}
Bacilli	10 to 80×10^{-10}

O_2 consumed not dependent on size only. *Pseudomonas* requires more than Enterobacteriaceae group for same amt. of cell substance. Eff. of energy utilization in bacteria not much greater than in animals. Apparently of same magnitude as that of cold-blooded animals. Media contg. sugars take up measurable O_2 in short time and possible to measure O_2 uptake of media separately from that of growing bacteria. III. *Oxygen Diffusion in Media.* O_2 diffusion rate slow. Measured simply by adding agar and methylene blue to medium, autoclaving till colorless and measuring advance of blue zone with time. In water agar, O_2 diffused 5 cm. in 24 hr., entirely insufficient to replace O_2 consumed by 10^7 or 10^8 cells per ml. In culture media, blue zone advances more slowly because medium itself combines with O_2. Media contg. carbohydrates take up more O_2 than without. Phosphates are active catalysts for oxidation, especially at pH higher than 6.0. IV. *Fate of Aerobic Bacteria After Exhaustion of Oxygen:* In medium satd. with O_2 from air, all D.O. exhausted when aerobic bact. multiplied to 2 to 10 million cells per ml. O_2 diffusion rate insufficient to provide entire culture with O_2. Aerobic bacteria fate at this point studied by comparing ordinary test tube or flask cultures with similar ones sealed with oil or paraffin using 1% soln. of peptone. Multiplication rate in both culture types identical until O_2 almost completely exhausted. Thereafter, not all bact. types behaved alike. Aerobic spore-formers died rapidly (13 to 50% of survivors per hr.) while *Pseudomonas fluorescens* continued multiplying very slowly in complete absence of O_2. Could be shown that vaspar (vaseline plus paraffin) seal sufficient to keep O_2 of air away from culture while mineral oil not sufficient. Besides, latter appeared suddenly toxic to bacteria when all O_2 exhausted, although they recovered later. Cause not detd. *Ibid.* **44:** 321 (Sept. '42; issued Nov. 1, '42). V. *Multiplication Curve.* Multiplication rate of most bacteria remains const. only few hr. because D.O. of medium soon exhausted. Thereafter, rate const. only at surface where O_2 available from air. Expts. indicate O_2 penetration not deeper than 2 mm. Below this stratum, facultative anaerobes multiply more slowly while strict aerobes usually decrease in no. VI. *Final Crops and Autotoxin Theory.* Aeration does not necessarily increase multiplication rate but keeps latter const. long time to produce larger bacteria crop. Aerated cultures may have 10 times bacteria of standing cultures. No. of *Streptococcus lactis* cells not greatly affected by aeration; decreased by pure O_2. VII. *Convection Currents.* Delayed start of aerated cultures explained by assumption that satd. O_2 soln. harmful to resting cells whose enzyme mechanism not working at normal rate of multiplying cells. Old cell in new environment establishes opt. conditions zone in immediate neighborhood, probably at expense of reserve compds. If this continually disturbed, e.g., by convection currents, cell finally dies from exhaustion. Good agar growth perhaps due merely to convection current prevention.—*Ralph E. Noble.*

Water Works Manpower and Military Service

The War Manpower Commission has promulgated several orders which have a bearing upon water works operations.

WMC Regulation No. 4 (immediately below) restricts the transfer of workers. It means to water works executives just this: Water works are an essential industry; therefore, the ability of another industry, even an essential one, to take away a water works employee is restricted by the terms of this order.

The revised Selective Service classifications (p. 645) are important in that they make it more necessary for water works executives to obtain Class 2–A status for key employees. This is the classification which they are entitled to claim for employees who hold jobs listed in Group 30 of the WMC List of Essential Occupations (for which see page 375 of the March and page 528 of the April issues of the JOURNAL).

Finally, the three articles concerning the WMC Procurement and Assignment Service Committee on Sanitary Engineering Personnel (pp. 646, 647, 649) are of great importance. They should be reviewed carefully.

TITLE 29—LABOR

Chapter VII—War Manpower Commission

Part 904—Restricting Transfer of Workers

REGULATION NO. 4

Pursuant to the authority vested in me as Chairman of the War Manpower Commission by Executive Order No. 9328, dated April 8, 1943, I hereby prescribe the following regulation:

§ 904.1. *Workers Previously Engaged in Other Than Essential Activities for Work in Essential Activities:* Any employer engaged in an essential activity may hire for work in such activity any new employee who, for the preceding 30 days, was not engaged in an essential activity.

§ 904.2. *Workers Previously Engaged in Essential Activities for Work in Other Than Essential Activities:* No employer shall hire for work in an activity other than an essential activity any new employee who, during the preceding 30-day period, was engaged in an essential activity if the wage or salary rate to be paid by the employer

would exceed the rate most recently earned by such employee.

§ 904.3. *Workers Previously Engaged in Essential Activities for Work in Other Essential Activities:* No employer shall hire (except as provided for in § 904.4 of this regulation) for work in an essential activity any new employee who, during the preceding 30-day period, was engaged in an essential activity if the salary or wage rate to be paid by the employer would exceed the rate most recently received during such period by the employee.

§ 904.4. *Workers Previously Engaged in Essential Activities for Work in Other Essential Activities in Areas or Industries Subject to War Manpower Commission Employment Stabilization Programs:* (*a*) Any employer engaged in an essential activity may hire for work in such activity any new employee who, during the preceding 30-day period, was engaged in an essential activity, without regard to his preceding wage rate or salary scale, providing such hiring is subject to, and permitted under, an employment stabilization program approved by the War Manpower Commission.

(*b*) A statement of availability shall be issued to any worker by his last employer or by the War Manpower Commission as may be provided in such employment stabilization programs and whenever the worker:

(1) is discharged by his last employer,

(2) is laid off for an indefinite period or for a period of 7 or more days, or

(3) can establish that his present employment does not utilize him at his highest skill or that he is not being employed at full time.

No statement of availability shall be issued solely on the ground that an individual's wage or salary rate is substantially less than that prevailing in the locality for the same or substantially similar work.

Any such statement shall contain the worker's name, his social security account number, if any, the name and address of the issuing employer or War Manpower Commission officer and office, the date of issuance, and a statement to the effect that the worker may be hired elsewhere in an essential activity. The inclusion by an employer on such notice of any information other than that required by this regulation shall be deemed to be a violation of this regulation.

§ 904.5. *Acceptance of Employment by Workers:* No individual shall accept new employment with an employer if the employer is prohibited from hiring him under this regulation.

§ 904.6. *Penalties:* The hiring by an employer of a new employee, or the acceptance by an individual of new employment, in violation of this regulation is subject to the penal provisions of the Act of October 2, 1942 (Pub. No. 729, 77th Cong.). The provisions of Sec. 4001.10 of the Regulations of the Economic Stabilization Director, issued October 27, 1942, apply to any wages or salaries paid in violation of this regulation.

§ 904.7. *Definitions:* (*a*) "Essential activity" means any activity in the War Manpower Commission List of Essential Activities [Group 30—Heating, Power, Water Supply and Illuminating Services, *for which see* the April JOURNAL, page 528, remains unchanged] and any activity approved by a Regional Manpower Director as a locally needed activity.

(*b*) "New employee" means any individual who has not been in the employ of the hiring employer at any

time during the preceding 30-day period.

(*c*) New employment means employment with an employer by whom the individual has not been employed at any time during the 30-day period preceding such employment.

§ 904.8. *Employee-Employer Agreements:* Nothing in this regulation shall be construed to prejudice existing rights of an employee under any agreement with his employer.

§ 904.9. *Effective Date:* This regulation shall become effective at 12:01 A.M., Sunday, April 18, 1943.

(signed)
PAUL V. MCNUTT, *Chairman*
War Manpower Commission
April 16, 1943

Approved:
(signed)
JAMES F. BYRNES
Economic Stabilization Director
April 16, 1943

Revised Selective Service Classifications

In accordance with the recent selective service order revising the status of childless married men, draft classifications have again been revised. Following is a complete list of the present classifications:

1-A: Available for military service
1-A-O: Conscientious objector available for noncombatant military service
1-C: Member of land or naval forces of the United States
2-A: Man necessary in his essential activity
2-B: Man necessary to the war production program
2-C: Man deferred by reason of his agricultural occupation or endeavor
3-A: Man with child or children deferred by reason of maintaining bona fide family relationship
3-C: Man with dependents who is regularly engaged in agricultural occupation or endeavor
3-D: Man deferred because induction would cause extreme hardship and privation to a wife, child or parent with whom he maintains a bona fide family relationship
4-A: Man 45 yr. old, or over, who is deferred by reason of age
4-B: Official deferred by law
4-C: Neutral aliens requesting relief from liability for training and service, and aliens not acceptable to armed forces
4-D: Minister of religion or divinity student
4-E: Conscientious objector available for work of national importance
4-F: Physically, mentally or morally unfit
4-H: Men deferred because their age group, 38-45, is not being accepted for military service; they now are being classified according to their status in the above categories in case of eventual call—a man falling into the 1-A class, for example, is classified 1-A-H.

Procurement and Assignment of Sanitary Engineers

War Manpower Commission Release

AS described in WMC Release PM–4285, dated January 18, 1943, published in the February JOURNAL (p. 265), WMC Chairman Paul V. McNutt has issued a directive placing the procurement and assignment of sanitary engineers under the WMC Procurement and Assignment Service for Physicians, Dentists and Veterinarians (PAS).

The personnel of the PAS Committee of Sanitary Engineers, set up to make the best use of the dwindling number of sanitary engineers for military, semi-military and civilian purposes was given in the previously published release. Since that time, however, J. K. Hoskins has left the committee and Paul Hansen, Cons. Engr., Chicago, has been appointed civilian consultant.

C. W. Klassen of the Army Sanitary Corps, formerly Chief San. Engr. of the Illinois State Dept. of Health, is being assigned by the Army to the WMC to handle sanitary engineering procurement under Dr. Max Lapham, executive officer of the PAS.

The object of the PAS, which is headed by Dr. Frank Lahey of Boston as chairman of the directing board, will be the same in regard to sanitary engineers as it is for the other three professions under its control, i.e., to provide the health protection required by the armed forces without depriving the civilian population of essential services. It will endeavor to maintain a well balanced allocation of sanitary engineers insofar as is practicable to meet both military and basic civilian needs.

For the purpose of administering this directive by the WMC, the professional occupation designation, "sanitary engineer," has been designated to "apply to a graduate of an approved scientific school who has fitted himself by suitable training or study and by experience to conceive, design, operate, direct or manage engineering works: (a) developed as a whole or in part for the protection and promotion of the public health; or (b) capable of injuring the public health through faulty conception, design, construction, operation or management. The basis for differentiation between individuals qualified as sanitary engineers and those qualified only as civil, mechanical, electrical, mining or chemical engineers shall be the ability to identify, evaluate and explain, in terms of their sanitary or public health implications, those factors connected with such engineering works as will prevent injury to health or will promote health in addition to the ability to conceive, design, operate, direct or manage such works."

The Needs, Functions and Objectives of the Sanitary Engineering Procurement and Assignment Service

By C. W. Klassen

SANITARY engineers trained to recognize and control environmental conditions which may cause diseases, often in epidemic form, have always been limited in number. Their activities during peacetime have resulted in disease prevention and health protection to the civilian population through improvements in sanitation which includes: the purification and protection of water supplies; control of swimming pools and bathing areas; the collection and proper disposal of wastes, particularly domestic sewage; the elimination and control of rodents and insects capable of carrying disease, especially mosquitoes which transmit malaria; and problems of industrial hygiene, housing, and others. Sanitation problems in this country are fairly well defined and valuable basic knowledge has been supplied the sanitation personnel in the Armed Forces for the solution of many problems now being encountered in many parts of the world.

The present critical shortage of trained sanitary engineers has been brought about by the needs of the Armed Forces for the services of such men to help protect our troops against many of the diseases transmittable through improper sanitation and insects. It has already been necessary to withdraw much trained personnel particularly from many of the state and local health agencies and from local water and sewerage departments; however, the military needs for such personnel have not yet been fully filled.

The War Manpower Commission is confronted with the problem of making the best use of the dwindling number of persons trained in sanitary engineering for military, semi-military and civilian purposes. In order to accomplish this, it is necessary to establish a more uniform system of procurement and assignment of such trained individuals than has been applied up to the present time. In order to assure sufficient trained personnel to maintain the necessary level of health protection through sanitation in the Armed Forces without depriving the civilian population of the essential health services furnished by such persons, this new Procurement and Assignment Service for Sanitary Engineers is now engaged in three principal functions: (1) determining the military and civilian needs for sanitary engineering personnel for this country and abroad; (2) estimating the availability of sanitary engineering personnel of various ages and grades of experience; and (3) establishing a plan for a well balanced allocation of such persons insofar as practicable to meet the civilian and military needs.

The need for trained personnel in the Armed Forces covers a wide field. A great variety of personnel is neces-

A paper presented on April 9, 1943, at the Illinois Section Meeting, Springfield, Ill., by Capt. C. W. Klassen, Sanitary Corps, detailed to Procurement and Assignment Service, War Manpower Commission, 1006 U St., Washington, D.C.

sary to cope with the control of environmental problems, many of which are peculiar to the areas where our fighting forces are located. These include new problems in water supply protection and treatment, insect-borne diseases such as malaria, yellow fever, filariasis, dengue, typhus and others. In this country many of the health problems encountered in the past among our own civilian population and with which we are familiar, are also those of the Armed Forces. Likewise in foreign lands, the disease hazards of the native population of an area where troops are located naturally becomes a matter of great importance to the Armed Forces. Problems previously known to us only through references or literature now become real. Wherever troops go, whether it be to a college or camp for training or to a theater of operation for combat, health protection through sanitation must be adequate. Thus we find trained personnel needed for malaria control units for operation in all parts of the world; men with design, construction and operation experience in water supply and sewerage facilities in addition to a knowledge of malaria control for activities in some regions. Sanitary engineers are needed for the camps in this country in connection with the medical department activities in the inspection, recommendation and supervision of the sanitary quality of water. Also, for example, in army air fields and our overseas bases, the Corps of Engineers design, construct and operate water supply facilities, while the medical department has the same duty in regard to the sanitary quality as it has at camps and posts in this country. Sanitary engineers are needed for all of the army's divisions and task forces. Sanitary engineers are included in the plan for the military government units which will operate in occupied areas. Later such engineers will also be necessary in the foreign relief and rehabilitation programs in such areas. The Corps of Engineers in the Army needs personnel for the operation of its water and sewerage utilities. Likewise, semi-military needs, primarily those of the United States Public Health Service, include personnel for malaria control in important war areas in this country, for industrial hygiene problems in the war industries, for general sanitation work in the state and local areas, in addition to the need for men for foreign service in the Pan-American Sanitary Bureau, in Hawaii on general sanitation, and in Alaska.

The number of trained sanitary engineers needed for the Armed Forces in this country and abroad for the coming year is now known. In determining the civilians needs, it will be necessary that the civilian use of such trained sanitation personnel be based upon the essentiality of the particular position, as it relates to the war effort. Many positions in the water works field, especially in important war areas, obviously come in this category. Some civilian sanitation activities not directly related to the war, but considered necessary during peace times, may have to be materially curtailed, dependent upon the available supply of trained personnel for civilian uses. In this connection, the Procurement and Assignment Service is keeping in mind that probably all of the trained personnel in this field below the age of 38 years that is physically fit for military duty will be utilized in the Armed Forces. Thus it must be anticipated that a further withdrawal of such men from their civilian positions is probable. It therefore becomes nec-

essary that no time be lost in training persons (both men and women) who are not qualified for military service, to replace these younger men. In the water supply field, water works organizations must share in this responsibility. Already a plan is under way in the field of public health to replace these younger trained men, by persons in the older age group after they have been given proper instruction and training. Similar plans are contemplated for such a replacement training program in other fields of sanitation such as in the operation of water and sewerage facilities.

To determine the availability of persons trained to meet all of these military, semi-military and civilian sanitation needs including those suitable for replacement training, a roster is being rapidly developed and the qualifications of persons are being reviewed to determine where they best may serve. It is to be noted that, aside from the announced official definition [*see* p. 650 of this JOURNAL], in exceptional circumstances, eight years of suitable experience and study that give evidence of the acquisition of proficiency in the fundamental engineering sciences as well as in engineering technique may be considered equivalent to graduation from an approved scientific engineering school.

According to the training and experience of an individual, he will fall into one or more of the following classes:

1. Public health
2. Design and construction of water, sewerage and drainage facilities
3. Management and operation of water and sewerage facilities
4. Industrial hygiene
5. Teaching and miscellaneous.

Obviously, the water works profession includes a large number of men coming within this definition and classification, both of which are sufficiently broad to include persons who will meet the civilian and military needs for sanitation personnel.

The A.W.W.A. and Procurement of Sanitary Engineers

THE undersigned, as Secretary of the American Water Works Association, recognizes the correctness of the position taken by the War Manpower Commission in its establishment of the Sanitary Engineering Procurement and Assignment Service. It appears that this service group has now proceeded far enough along the path planned for it to be considered by civilians, as well as by the military agencies, as the clearing house for information concerning sanitary engineering personnel and procurement of such individuals.

It is now the fixed policy of this office to refer all requests for skilled sanitary engineering personnel received from military agencies to the Sanitary Engineering Procurement Service. It is also the policy of this office to refer all requests received from men of such skills asking for assistance in obtaining employment to the same service. This office does not however put forward to any agency the name of any individual *presently employed* in the field of public water supply or public sanitation. This is because there is full evidence that water

supply organizations are already severely reduced in personnel because of departure of employees either into other civilian industry or into the armed services either by way of selective service induction or voluntary entry into the army, etc.

Losses in some water departments have been as high as 25 per cent of pre-war personnel, with an increase instead of a decrease in the requirements for water service.

There remains a reservoir of skilled water works personnel which is available to the armed forces but which is only rarely being used in water supply work. This reservoir is the large body of young water works employees who have been inducted into service as selectees. While the need for men to operate and supervise water, sewer and other services is known to many responsible officers, the assignment of trainees, skilled in such work in their civilian life, to similar work in military centers is made both reluctantly and rarely. When an intelligent understanding of the entire manpower situation is reached, there can remain no significant barrier to the use of the Sanitary Engineers, Chemists and Skilled Technicians, already drawn from the water supply field into the army and navy, at military service for which their civilian skill and training fits them and at work for which the military services need them.—HARRY E. JORDAN, *Secretary, A.W.W.A.*

Legal Aspects of Civilian Defense Volunteer Services in Michigan

By George R. Sidwell

GOVERNMENTS are created and operated entirely by legal machinery which, in time of war, must be adjusted to war needs. This great war of today has thrown upon the machinery of government, functions and duties which heretofore have never been needed, nor even contemplated. Today, practically all states have defense or war councils, and cities, almost without exception, either have their own defense councils or are integrated into a state or regional system.

In some states, e.g., Virginia, New Jersey, Massachusetts, New York and Michigan, the governor or the state war council is the supreme authority for practically all phases of civilian defense. In Michigan, under new legislation just become law, the Governor is the supreme agency and the Michigan War Council functions only in an advisory capacity. Although the Governor appoints a Director of Civilian Defense to do all the work, the final responsibility for civilian defense rests upon him alone.

The workings of the Michigan Civilian Defense Act are not of concern to this discussion except insofar as they pertain to the legal aspects of volunteer services and insofar as these aspects affect the volunteers individually. Of first importance in this respect is the relationship between the volunteer defense worker and the governmental unit to which he is responsible. To understand this relationship it must be remembered that the entire Michigan civilian defense structure is established by a law, under which the county and municipal defense councils establish the various local defense volunteer agencies in accordance with the rules and regulations of the State Director of Civilian Defense. This statute also contains a provision that the local defense councils shall utilize existing departments of local government. Thus, as volunteer civilian defense workers, water works men may be associated with their local water works operation and still maintain their status as employees. If, on the other hand, they are volunteers in defense work not related to water works operation, they become "creatures" of the local defense council and, as such, are in no way agents or employees of the city, village or township water works authority. Further, in the author's opinion (although the courts may eventually decide otherwise), as volunteer workers, they are neither agents nor employees of the local defense council.

A paper presented on April 21, 1943, at the Michigan Section Meeting, Ann Arbor, Mich., by George R. Sidwell, Michigan Municipal League, Ann Arbor, Mich.

Rather, their status is purely that of volunteers, just as their designation implies. This has also been the opinion of the California Attorney General, a committee of attorneys of Dane County, Wis., and of the Wisconsin Attorney General in analogous cases.

Application of Michigan Law

The Michigan statute takes cognizance of this situation and specifically states that neither the state nor any political subdivision of the state, nor the agents or representatives of the state (meaning the state and local defense councils), or any subdivision thereof, shall be liable for personal injury or property damage sustained by any person appointed or acting as a civilian defense worker. The act further specifically states that there shall be no liability on the part of the state, its subdivisions, its agents, or on the part of any volunteer defense worker, to third parties who are killed or injured in person or in property through any act arising out of the performance of duties of civilian defense as set forth in the act or in any precautionary measures or ordinances of any political subdivision of the state.

There are two exceptions to these exemptions from liability as set out in the act. The first is that the provisions of the act shall not deprive any person of rights possessed by him under the workmen's compensation law or any pension law or any act of Congress. The second is that the exemption from liability to third persons shall not apply in the case of willful misconduct.

The workmen's compensation aspect may be of aid to regular employees, who are actually employees of a water works system, even when doing emergency work. It is small help to the volunteer, however, because there exists no employer-employee relationship between him and the water works authorities or the defense council upon which to base a claim for workmen's compensation.

As to the benefits which might be realized out of pension systems, there is no uniformity from city to city. Likewise, there is, at present, no act of Congress covering indemnity to persons injured in civilian defense activities. However, $5,000,000 has been set aside in the President's budget for the executive branch of the federal government [*see* p. 657, for discussion of the federal War Civilian Security Program]. About 500 claims have been paid out of this fund to date.

Finally consideration must be given to the question of willful misconduct, i.e., such acts as assault, reckless driving and the like. The Michigan Attorney General has ruled that a county, in performing the functions required of it under 1941 Civilian Defense Act, is performing a governmental function. Nothing in the new act of 1943 seems to justify a different interpretation of this situation, except perhaps to strengthen the rule itself.

Although the question answered by the Attorney General related only to counties, his holding is equally applicable to cities, villages and each defense council. As a result there is a very strong probability that governmental units will not be held liable for deaths or injuries to persons or property arising out of willful misconduct of volunteer defense workers. Liability in such instances will be on the person who has committed the misconduct.

The applications of law and the conclusions which have been drawn there-

from are just as applicable to practice blackouts and defense situations as to actual enemy attack. These practice situations are just as essential as the actual performance of duties under genuine alarm. They are contemplated by the statute as a part of the training program.

The lack of liability on the part of governmental units and of volunteer workers may seem unfair to some, especially to those who may suffer injury or damage during a practice or simulated attack. Nothing, however, must be allowed to interfere with the home defense program. Throughout the nation some governmental units have been holding back because they are afraid of incurring liability. In time of actual attack, a little holding back may increase our losses manyfold. This is not the road to victory.

War Civilian Security Program

Medical and Cash Benefits for Injuries to Civilian Defense Workers

OFFICE of Civilian Defense Operations, Letter No. 95, December 1, 1942, discusses the President's allocation of $5,000,000 to the Federal Security Agency (FSA) to provide temporary aid to civilian defense workers injured "while in the performance of their duties" and also to dependents of such civilian defense workers injured or killed under like circumstances. This program will be known as the War Civilian Security Program and will be administered by the FSA. The FSA has assigned the medical care for injured civilian defense workers to the U.S. Public Health Service to be operative through the Emergency Medical Service of the Citizens Defense Corps, which will act on its behalf.

As the need for relief must be occasioned while working in line of duty, the activities of members of the Citizens Defense Corps will be considered to be performance of official duties if such activities are part of officially prescribed training or practice directed toward a more effective civilian protection organization. It is to be noted that all field training is deemed to be in the performance of duties. To persons registered for training who are not yet duly enrolled members, but who are covered by the War Civilian Security Program, performance of duty shall likewise include prescribed courses and field service.

In addition to medical treatment, public assistance to civilian defense workers injured on official duty, or to

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An abstract of OCD Operations Letters 95, 117 and 118, Circular War Series No. 4, U.S. Citizens Defense Corps Regulation No. 3 and "Temporary War Civilian Security Program of the Federal Security Agency as It Affects Certain Civilian Defense Workers Injured on Duty," an OCD release, made available by Major John H. Brewster, San. Engr., U.S. Public Health Service (R), Second Civilian Defense Region, OCD, New York. The above publications are available through the national and state OCD offices.

their dependents who are in financial need, will be administered by the Social Security Board, through its Bureau of Public Assistance. Such assistance will be provided through state and local public assistance agencies acting in behalf of the federal government, either expending federal funds or receiving federal reimbursement for state and local funds expended in accordance with the instructions of the Bureau of Public Assistance. Another benefit provides that, if the civilian defense worker dies as a result of his injuries, burial expenses, not to exceed $100 in any case, may be paid.

Additional Coverage

A point of interest is that, although it will not be the policy of the U.S.P.H.S. to duplicate any medical care which the injured worker has received or is eligible to receive under any other federal, state or local government plan, the U.S.P.H.S. will furnish medical care to the extent that it is not furnished under any other such plan, when such additional care is deemed to be necessary for proper treatment. This means that not only a volunteer worker, but a regular employee of a utility, who is registered as a civilian defense worker, when injured in line of duty by enemy action, is entitled to the benefits of the War Civilian Security Program to the extent that the care provided under any other federal, state or local government plan is not equivalent to what the U.S.P.H.S. deems necessary in its administration of this aspect of the program.

Definitions

Since the War Civilian Security Program provides relief only when the civilian defense worker is killed or injured in the performance of official duties, a careful determination of what constitutes such duties is necessary. To provide for this, Sec. 12 of U.S. Citizens Defense Corps Regulation No. 3 prescribes the general duties of a member of the Citizens Defense Corps, "who has registered for training or instruction, has been appointed to membership, has signed the prescribed oath, has received a Certificate of Membership and has been enrolled as a member of the defense corps by the local defense council, all in accordance with these Regulations, and whose membership has not been suspended or terminated as provided in these Regulations."

These regulations also differentiate between workers and trainees, a trainee meaning "a person eligible for membership in the Citizens Defense Corps, who has registered for training in accordance with these Regulations and who is engage in taking prescribed and approved courses of training or instruction prior to becoming appointed and enrolled as a member." Thus, a registrant for training "shall complete, in a manner satisfactory to the Commander of his local defense corps, courses of training or instruction prescribed and approved by order of the Director for the particular unit of the defense corps."

Utility Repair Squads

The training for utility repair squads, including those for water works, sewer, gas, electricity and road authorities, in addition to what is required by the local superintendent or the state coordinator, simply requires that the squad have three hours of gas defense largely for their own protection, and five hours of general training. Applicants for utility repair squads who are

employed to do repair work for publicly or privately owned water, gas, electric or other utilities, and this includes the permanent personnel, may omit all training and instruction courses, but fire defense and gas defense training are recommended. It must be borne in mind, however, that, to be eligible for any of the War Civilian Security Program benefits, the person must have been signed up for the local U.S. Citizens Defense Corps at the time of his injury or death.

For the administration of this program, there has been set up in each community a Personnel Officer of the Citizens Defense Corps, who will certify as to the status of a claimant for relief under the War Civilian Security Program and as to whether the injury or death was sustained in performance of official duties. The Personnel Officer's certification will be subject to review by the OCD in light of all circumstances in the case. The FSA reserves the right to review and evaluate the facts in all cases where claims are filed.

Limitation on Purchases of Motors and Generators

LIMITATION Order L–221, which covers the purchase of electrical motors and generators, has been amended as of April 22, 1943. Since the order materially affects the purchase of such equipment, water works executives should obtain a copy from the nearest WPB office if their plans call for buying motors or generators in the near future.

One significant sentence in the order should be considered in connection with the restrictions on water works inventory. Limitation Order L–221 authorizes operating *spares* to the extent of 3 per cent of motors in the same category in operation or "in any event, one operating spare in each category."

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Part 1075—Construction

CONSERVATION ORDER L–41 AS AMENDED APRIL 20, 1943

Conservation Order L–41 as heretofore amended is hereby amended to read as follows:

§ 1075.1. *Conservation Order L–41*

(a) *Definitions:* For the purpose of this order:

(1) "Person" means any individual, partnership, association, business trust, corporation, governmental corporation or agency, or any organized group of persons, whether incorporated or not.

(2) "Construction" means the erection, construction, reconstruction, restoration or remodeling of any structure or project, or additions thereto or extensions or alterations thereof, but not including:

(i) "Maintenance and repair" as defined in paragraph (a)(12);

(ii) The excavation or other movement of earth where no material except earth or other unprocessed material is to be incorporated.

(3) "Residential construction" means any construction where the principal designed function of the structure or project is or will be to provide living space or accommodations.

(4) "Multiple residential construction" means any residential construction where the principal designed function of the structure or project is or will be to provide living space or accommodations for six or more families, or which is divided or to be divided into six or more suites.

(5) "Agricultural construction" means any construction (other than residential construction), where the principal designed function of the structure or project is or will be the production of agricultural products including, but not limited to those produced by farmers, planters, ranchmen, dairymen, poultrymen or nut or fruit growers.

(6) "Industrial construction" means any construction where the principal designed function of the structure or project is or will be the manufacture, processing or assembling of goods or materials.

(7) "Other restricted construction" means any construction, other than residential, multiple residential, agricultural or industrial construction, including, but not limited to, commercial, highway, roadway, subsurface, railroad and utilities construction, whether publicly or privately financed.

(8) "Project" means all separate structures or units of construction situated in close proximity to each other and integrated to serve a single general use; it does not mean a particular construction operation or job. In no case shall a single structure or unit of

construction be subdivided into more than one project for the purpose of this order.

(9) "Begin construction" means to initiate construction or to resume construction which has not been carried on as one continuous construction job, by physically incorporating or installing into a structure or project on the site, material which is to be an integral part of the structure or project.

(10) "Cost" shall be the sum of the total cost or value, whichever is higher, of the following (except as qualified in (a)(11) below):

(i) Material which is to be an integral part of the structure or project, including articles, chattels or fixtures which are to be physically incorporated in and used as a part of the structure or project, or are to be so substantially affixed thereto that they cannot be detached without materially injuring them or the structure or project;

(ii) Labor engaged in the construction;

(iii) Architects' engineers' and contractors' services.

(11) "Cost" does not include the following:

(i) The value of used material, articles, chattels or fixtures which have been severed from the same or another structure or project and are to be used without change in ownership, nor the cost or value of labor engaged in incorporating the same;

(ii) The cost or value of production machinery or equipment to be used directly in the manufacturing, processing or assembling of goods or materials;

(iii) The value of labor, not entailing financial outlay, of an owner or tenant and members of the owner's or tenant's immediate family residing with him, on a structure or project owned or leased by him.

(12) "Maintenance and repair" means such work as is necessary to keep a structure or project in sound working condition, or to rehabilitate a structure or project or any portion thereof when the same has been rendered unsafe or unfit for service by wear and tear or other similar causes. The term does not include any building operation or job where a structural alteration or change in design is to be made. However, different materials may be used and different types of articles, chattels or fixtures (but of the same general nature) may be incorporated, provided that there are no such structural alterations or changes in design. No building operation or job may be part construction and part maintenance and repair, as the terms are used herein, but if any construction is to be done, the entire building operation or job is construction. Maintenance and repair does not include the reconstruction or restoration of a structure or project or portion thereof destroyed by fire, flood, tornado, earthquake, act of God or the public enemy.

(b) *Prohibited Construction:*

(1) No person shall begin construction, carry on any construction begun in violation of any order in the L–41 series, cause such construction to be begun or carried on or participate in such construction, or order, purchase, accept delivery of, withdraw from inventory or in any other manner secure or use material for such purposes.

(2) The terms and restrictions of (b)(1) shall not apply where the construction is of:

(i) A structure or project to be the property of the Army or Navy of the United States, the United States Maritime Commission, Panama Canal, the Coast and Geodetic Survey, the Coast Guard, the Civil Aeronautics Author-

ity or the Office of Scientific Research and Development;

(ii) A structure or project which is to be used directly in the discovery, development or depletion of mineral deposits;

(iii) A type subject to the provisions of any order in the M–68 series (Part 1047) relating to the production and distribution of petroleum, or is of a type subject to the provisions of any Petroleum Administrative Order (Chapter XIII), and such construction is permitted only to the extent authorized by the applicable order in the M–68 series or by the applicable Petroleum Administrative Order;

(iv) Telephone facilities or equipment, including facilities or equipment for such telegraph or teletypewriter service as may be conducted by a telephone operator, other than buildings, and is authorized or permitted under the terms of Order L–50 (§ 1095.1);

(v) Railroad tracks, together with necessary operating facilities, but not including buildings, tunnels, overpasses, underpasses or bridges;

(vi) Facilities, other than buildings, to be owned by a producer, as defined in Order P–46 (§ 978.1), pertaining to utilities and which are to be used directly in providing one or more of the services set forth in paragraph (a)(1) of said order;

(vii) Irrigation pipelines or drainage tile drains, classified as agricultural construction under this order, in which no materials except earth or other unprocessed material or clay or non-reinforced concrete tile not more than 12 in. in internal diameter are incorporated.

(viii) Agricultural construction necessary to the installation of material or equipment, the distribution of which is controlled by Order L–170 (§ 1029.10) or orders in the M–21 series (Part 962), and which are listed in Schedule 1 of Food Production Order 3 of the United States Department of Agriculture.

(ix) A structure or project for which no material will be used to provide electric, gas, water, steam or sanitation services for the incorporation of which specific authorization is required under orders in the U series (unless such authorization has been received before construction was begun) provided it is:

(*a*) Residential construction and not multiple residential construction, or is specifically listed on Schedule B attached hereto, and the estimated cost is less than $200, or

(*b*) Multiple residential, agricultural or other restricted construction, is not specifically listed on Schedule B, and the estimated cost is less than $1000, or

(*c*) Industrial construction, is not specifically listed on Schedule B, and the estimated cost is less than $5000, or

(*d*) The minimum construction necessary to make safe and to protect any structure or project (or the contents thereof) damaged or destroyed by fir flood, tornado, earthquake, act of Go or the public enemy, or

(*e*) Agricultural construction and the immediate construction thereof is determined by the United States Department of Agriculture, in accordance with such administrative procedures as may be from time to time prescribed, to be necessary to avert threatened loss of farm products: *Provided*, That within two weeks of such determination Form PD–200 is filed in accordance with the provisions of paragraph (f) of this section.

(3) The terms and restrictions of (b)(1) shall not apply where the construction is to reconstruct or restore

(i) Residential or multiple residential construction damaged or destroyed by fire, flood, tornado, earthquake, act of God or the public enemy, or to build in its place and stead new residential or multiple residential construction: *Provided, however,* That the estimated cost of such reconstruction, restoration or new construction shall be less than $5000, and that within two weeks of such damage or destruction Form PD–105 (for residential) or Form PD–200 (for multiple residential) is filed in accordance with the provisions of paragraph (f) of this section;

(ii) Agricultural construction damaged or destroyed by fire, flood, tornado, earthquake, act of God or the public enemy where the immediate reconstruction thereof is determined by the United States Department of Agriculture, in accordance with such administrative procedures as may be from time to time prescribed, to be essential to the agricultural program: *Provided,* That within two weeks of such damage or destruction Form PD–200 is filed in accordance with the provisions of paragraph (f) of this section;

(iii) Industrial or other restricted construction, not specifically listed on Schedule B, damaged or destroyed by fire, flood, tornado, earthquake, act of God or the public enemy, where the immediate reconstruction thereof is necessary for the prosecution of the war or the protection of public health or safety: *Provided,* That within five days of the damage or destruction notice thereof is given by telegraph to the War Production Board setting forth (*a*) the cause of the damage or destruction, (*b*) the function of the structure or project which has been damaged or destroyed, (*c*) the type of construction, (*d*) why immediate reconstruction or restoration is necessary, and (*e*) the estimated cost of reconstruction: *And provided further,* That within two weeks of the giving of such telegraphic notice, Form PD–200 is filed in accordance with the provisions of paragraph (f) of this section.

Nothing contained in this subparagraph (3) shall be interpreted as a commitment that priorities assistance will be accorded to any particular construction authorized by the provisions of this subparagraph and the War Production Board may at any time either order said construction to cease or require any modification thereof that seems to it to be proper.

(4) The terms and restrictions of (b)(1) shall not apply where the construction has been or is hereafter authorized by the Director of Priorities of the Office of Production Management or by the War Production Board by the issuance of:

(i) One of the preference rating orders or certificates listed on Schedule A attached hereto, as that schedule may be amended from time to time, according priorities assistance to the construction; or

(ii) An order specifically authorizing the construction.

(5) The exceptions set forth in paragraphs (b)(2)(ix)(*a*), (b)(2)(ix)(*b*) and (b)(2)(ix)(*c*) shall not be construed to authorize separate or successive construction operations commencing after September 6, 1942, the aggregate cost of which over any continuous twelve-month period exceeds the amount specified in the applicable paragraph for the particular structure or project; not including in said aggregate cost the cost of any construction thereon during said period authorized under the provisions of para-

graph (b)(2)(ix)(*d*), (b)(2)(ix)(*e*), (b)(3) and (b)(4).

(c) *Prohibited Deliveries:* No person shall accept an order for, sell, deliver or cause to be delivered material which he knows, or has reason to believe, will be used in violation of the terms of this order.

(d) *Further Construction Limitations:* Nothing in this order shall be construed to authorize the use or delivery of any material or the application or extension of any preference rating in violation of the provisions of any conservation, limitation or other order or regulation heretofore or hereafter issued by the Director of Priorities, Office of Production Management, or by the War Production Board.

(e) *Orders or Certificates Not Constituting Authorization:* The assignment of a preference rating by a PD–1, PD–1A or other certificate, or by any order, other than those listed on Schedule A, shall not constitute authorization to begin construction.

(f) *Application for Authority to Begin Construction:*

(1) The application forms prescribed by paragraphs (f)(2) and (f)(3) hereof shall be executed by the person who is or is to be the owner of the structure or project for which authorization is required by the terms of this order, or his duly authorized agent.

(2) If the applicant requires priorities assistance for the proposed construction, an application shall be made for the appropriate preference rating order or certificate listed on Schedule A on the form referred to therein.

(3) Where the applicant does not require priorities assistance, application for specific authorization to begin construction referred to in paragraph (b)(4)(ii) hereof may be made by filing Form PD–200, or such other forms as may hereafter be prescribed. Such forms are to be filed in the manner prescribed on Schedule A for the filing of applications for Preference Rating Order P–19–h.

(g) *Violations:* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States, is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining any further deliveries of or from processing or using, material under priority control and may be deprived of priorities assistance.

(h) *Communications.* Applications, communications and reports under this order shall, unless otherwise directed in Schedule A or by specific instructions be addressed to: War Production Board, Washington, D.C., Ref: L–41.

Those relating to residential construction shall in addition be conspicuously marked "Res.," those relating to multiple residential construction "M. R.," those relating to agricultural construction "Agr.," those relating to industrial construction "Ind." and those relating to other restricted construction "O.R."

This order, as amended, shall supersede all orders, amendments and interpretations in the L–41 series issued prior to February 19, 1943, except L–41–a, L–41–b and its interpretation and L–41–c.

Issued this 20th day of April 1943.

WAR PRODUCTION BOARD
By J. JOESPH WHELAN
Recording Secretary

Schedule A

The following preference rating orders and certificates are listed pursuant to paragraph (b)(4)(i) of the above order. A general description of the type of construction covered by each, the appropriate application form and where such form should be filed, are given solely for the purposes of identification.

Preference Rating Order	Type of Construction	Application Form	Where Filed
P-14-a	Shipyards and shipways	No form	Maritime Commission, Washington, D.C.
P-14-b			
P-19	Structures or projects important to the war effort and essential civilian needs, other than housing	No further application accepted under P-19 and P-19-a; apply for P-19-h	
P-19-a			
P-19-d	Publicly financed war housing	No further applications accepted; see P-19-h	
P-19-g			
P-19-e	Public roads	Application is made by or through the Public Roads Administration of F.W.A.	
P-19-h	Structures and projects important to the war effort and essential civilian needs, including war housing owned by FPHA and farm dwellings (for other housing see P-55 below)	Form PD-200	At the following places or such other places as may be prescribed: Agricultural and farm dwellings with Department of Agriculture County War Board having jurisdiction over location of the site. All other types of construction with War Production Board, Washington, D.C.
P-19-i			
P-41	Construction of air transport facilities	Expired Oct. 1, 1942	
P-55	Housing and Remodeling of housing except farm dwellings and housing owned by the FPHA	Form PD-105 and Form PD-105A	With FHA field office having jurisdiction over location of the site
P-55, amended			
P-89 as amended	Construction of certain types for production of chemicals	Form PD-315	With War Production Board Washington, D.C., Ref: P-89
P-98-b	Construction related to petroleum enterprises as defined and limited therein	See orders in M-68 series	
P-110	Remodeling of housing programmed for critical areas by the National Housing Agency	No further applications accepted	
P-130	Construction of certain facilities other than buildings by telephone companies and construction by such companies of facilities necessary to serve defense projects	See order Form PD-685	With War Production Board, Washington, D.C., or such other place as may be prescribed
P-132	Construction of certain facilities other than buildings by telegraph companies and construction by such companies of facilities necessary to serve defense projects	See order Form PD-683	With War Production Board, Washington, D.C., or such other place as may be prescribed
Certificates:			
PD-3 PD-3A	Certain specific types of construction of the Army or Navy	PD-3A	With the contracting or procurement official having jurisdiction of the contract

Schedule B

The following structures or projects are listed pursuant to paragraphs (b)(2)(ix) and (b)(3)(iii) of the above order:

(a) A structure or project which has as its principal designed function:

(1) Public or private amusement, entertainment or recreation, with the exception of playgrounds for children;

(2) Occupancy by not more than five establishments selling or dispensing goods, merchandise, food or drink, or providing services;

(3) Use as a club, lodge, fraternity or sorority house, association, auditorium or assembly hall;

(4) Manufacture, processing or assembling of any one or more of the following:

(i) Athletic supplies, sporting goods or toys or games as defined in Order L–81,

(ii) Beverages, except milk,

(iii) Books, magazines, newspapers, greeting cards or other printed or engraved matter,

(iv) Candy or chewing gum,

(v) Cigars, cigarettes, smoking or chewing tobacco or snuff,

(vi) Jewelry, watches, traveling bags, brushes, razors, pipes and like articles for personal use or adornment,

(vii) Furniture, silverware, china, household electrical appliances, draperies and all other similar articles,

(viii) Musical instruments,

(ix) Stationary or office supplies,

(x) Toiletries or cosmetic products, as defined in Order L–171,

(xi) Wearing apparel of every sort, nature or description, except for the Army or Navy;

(b) Industrial construction with a productive floor area of less than 10,000 square feet.

Interpretation 1

(a) Paragraph (a) of Conservation Order No. L–41, as amended, places in different classes the construction of various structures or projects and paragraph (b)(2)(ix) provides the limits within which the several classes of construction may be begun without authorization. Any structure shall be classified in accordance with such provisions unless it constitutes a part of a "project" as defined in paragraph (a)(8), in which event the classification of the project shall control.

(b) In connection with paragraphs (a)(3), (a)(4), (a)(5), (a)(6) and (a)(7), where part of a structure or project falls within one class under said order and other parts within another or other classes, the predominant designed use shall determine the classification of the whole structure or project.

(c) In connection with paragraphs (a)(5) and (a)(7), a structure to be used primarily for the storage of farm products which are produced by a person other than the proprietor of such structure shall be interpreted to be "other restricted construction."

(d) "Construction" as defined in paragraph (a)(2) includes the laying of asphalt tile, linotile, cork, tile, rubber tile and linoleum, if the same is cemented to or in any way is affixed to the construction.

(e) The application of siding or roofing is "construction" as the word is used in paragraph (a)(2), where such siding or roofing is applied to a portion of a building or structure which is not in need of "maintenance and repair" as the words are used in paragraph (a)(12).

Utilities Orders U-1, U-1-d and U-1-e as Amended

Utilities Order U–1 as originally issued on February 24, 1943, with interpretative comments, was mailed to all members under date of February 27, but was not published because of the imminence of its amendment. The main revisions of the original document are discussed in the Administrative Letter immediately below. Editorial comments on this amended form appear on page 1 of the "News of the Field" section of this JOURNAL. *Orders U–1–d and U–1–e with Administrative Letters begin on pages 682 and 685, respectively.*

Administrative Letter to All Electric, Gas, Water and Steam Utilities—April 17, 1943

UTILITIES ORDER U–1 AS AMENDED

UTILITIES Order U–1 has been amended to clarify certain provisions and to remove others which ceased to be effective after March 31, 1943. No modification of the fundamental structure of the order has been made. The principal changes are:

Paragraphs (b), (d) and (e), relating to the assignment of preference ratings and allotments of controlled material, introduce a simplified procedure. The new certification of paragraph (e)(1) is to be placed by producers on their purchase orders for materials ordered for maintenance, repair and as operating supplies, whether the order covers controlled materials or not.

When an order for controlled materials is placed with a manufacturer or a distributor (rather than with another utility) U–1 now suggests that the preference rating be omitted, although the same certification should be used and the allotment symbol MRO–U should appear on the order.

A new restriction has been placed on the use of U–1 preference ratings by the addition of a subparagraph to paragraph (c) and the incorporation of a new schedule, Schedule E. None of the material listed in Schedule E may be purchased on an order rated under U–1. This change is in line with WPB policy in other orders.

Former subparagraphs (f)(1)(i) and (f)(1)(ii) have been dropped from the order. These provisions restricted purchases of certain classes of material from suppliers who are not utilities. The restrictions of paragraph (j), which require a check with the Regional Inventory Control Office prior to the purchase of certain items named in Schedule C, substitute a different type of control for the deleted provisions of paragraph (f).

A change in (f)(2)(ii) makes it possible to increase practical working minimum inventory in certain production classes of material to reflect increases in system output in the twelve months preceding the current calendar quarter over system output in 1940. The change has been made to eliminate variations in practical working mini-

mum inventory resulting from computations made on the basis of comparable calendar quarters. A similar change has been made in (f)(4)(ii).

A new paragraph (f)(4)(vi) provides for seasonal variations in withdrawal requirements. Under the provisions of this paragraph, withdrawal quotas will be calculated on a calendar year basis. For example, relatively large withdrawals may be made in the third quarter of 1943, provided that the producer compensates for this by decreasing withdrawals in other quarters, so that total withdrawals for the year are not greater than the sum of the quotas for withdrawals for all four calendar quarters of the year.

Paragraph (f)(5)(i) has been amended to clarify the conditions which must be satisfied before a producer may accept delivery of "short items." Under the amended order, the following conditions must be satisfied:

A. Material in excess inventory must be:
   1. Recorded continuously on the producer's records as excess,
   2. Continuously held for sale,
   3. Reported to the War Production Board when and as the producer is required to do so.

B. The procedure described in (f)(5)(ii) must be followed.

In subparagraph (f)(5)(ii), the words "separately accounted for" have been changed to "recorded." This has been done to avoid any implication that producers are required to keep a duplicate set of stock records in order to be able to record inventory transactions with respect to transfers from excess to practical working minimum inventory.

A similar clarification as to reporting has been made by striking out the requirement that *all* producers must report inventory on Forms PD–193B, 194B or 195B. Reports should be filed only as requested. The first sentence under Schedule A has been modified accordingly.

The Regional Inventory Control Offices, set up to handle the inventory redistribution program which is implemented by paragraph (j) of U–1, have now been established in thirteen War Production Board field offices. A list is attached to this letter showing the location of these offices, the region covered by each office and the name of the engineer in charge. Your inquiries for information as to where needed materials and equipment may be purchased should be directed to the office in your region. In addition, future filing and reporting in connection with excess inventories will be handled through these regional offices.

The $100 limitation on Schedule C items is intended to apply to the numbered subsections of Schedule C. If, for example, several sizes or types of transformers are ordered and the value of each size or type is less than $100, but the total value of *transformers* being purchased is more than $100, clearance must be obtained. On the other hand, if a prospective purchase of transformers will amount to less than $100 and a prospective purchase of wire will amount to less than $100, clearance need not be obtained even though the sum of the two is more than $100, although it would of course be helpful to the war effort if an effort is made in every case to secure the material from another producer's excess stock.

If there are any questions regarding paragraph (j) of U–1 or the redistribution plan, please submit them to the appropriate Regional Control Office.

(signed)
J. A. KRUG, *Director*
Office of War Utilities

Regional Inventory Control Offices

NOTE: *The title "Regional Utility Engineer, Utility Inventory Control Office, War Production Board" has been omitted from each listing in the column "Engineer and Address," but should be included in the address of all communications.*

Region	*States Included*	*Engineer and Address*
I	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	Ralph E. Walters 17 Court St. Boston, Mass. (Lafayette 7500)
II	New Jersey (approximately the north half), New York	Paul M. Gee 122 E. 42nd St. New York, N.Y. (Murray Hill 3-6805)
III	Delaware, Maryland (except a small portion of Western Maryland), New Jersey (approximately the south half), Pennsylvania (Eastern), Virginia	C. H. Zur Neiden 1617 Pennsylvania Blvd. Philadelphia, Pa. (Locust 3400)
IV	Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee	R. L. Leach 116 Candler Bldg. Atlanta, Ga. (Walnut 4121)
V	Kentucky, Ohio (except Toledo), Pennsylvania (Western), West Virginia	R. C. Wenz 800 First National Bank Bldg. Pittsburgh, Pa. (Grant 5370)
VI	Illinois, Indiana, Iowa, Wisconsin	Arthur Wallace 226 W. Jackson Blvd. Chicago, Ill. (Andover 3600)
VII	Arkansas, Kansas, Missouri, Nebraska	Charles A. Haskins Mutual Interstate Bldg. Kansas City, Mo. (Victor 7780)
VIII	Louisiana, Oklahoma, Texas	Elgin Robertson 910 Fidelity Bldg. Dallas, Tex. (Riverside 5711)
IX	Colorado, Montana, New Mexico, Utah, Wyoming	Harold L. Vaughn 617 Kittredge Bldg. Denver, Colo. (Tabor 8173)
X	Arizona, California, Nevada	W. J. McCullough 1031 S. Broadway Los Angeles, Calif. (Ri 1261)
XI	Michigan, Ohio (Toledo only)	C. T. Van Dusen 7310 Woodward Ave. Detroit, Mich. (Trinity 2–4900)
XII	Minnesota, North Dakota, South Dakota	H. E. Kahlert 326 Midland Bank Bldg. Minneapolis, Minn. (Main 3244)
XIII	Idaho, Oregon, Washington	Verne Hansen Bedell Bldg. Portland, Ore. (Broadway 8471)

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Subchapter C—Director, Office of War Utilities

Part 4500—Electric, Gas, Water and Steam Utilities—Materials

UTILITIES ORDER U-1 AS AMENDED APRIL 17, 1943

§ 4500.1 *Utilities Order U–1*—(a) *Definitions for the purpose of this order:* (1) "Producer" means any individual, partnership, association, corporation, governmental corporation or agency, or any organized group of persons, whether incorporated or not, located in the United States, its territories or possessions, engaged in or constructing facilities for the purpose of engaging in, one or more of the following services, whether or not such producer has applied the preference ratings herein assigned:

(i) Supplying electric power directly or indirectly for general use by the public

(ii) Supplying gas, natural or manufactured, directly or indirectly for general use by the public, exclusive of the production and transmission of natural gas up to the point of its entry into gas transmission lines from field gathering lines

(iii) Supplying water directly or indirectly for general use by the public, other than exclusively for irrigation purposes

(iv) Supplying central steam heating directly or indirectly for general use by the public

(v) Supplying any of the foregoing services, but not for general use by the public, provided that a specific direction from the War Production Board entitles such person or agency to apply the ratings herein assigned. Application for such a specific direction should be made by letter to the War Production Board, Washington, D.C., Ref: U–1.

(2) "Producer" also means any producer, as defined in paragraph (a)(1), but located in the Dominion of Canada, to whom and in whose name a copy of this order has been specifically issued by the War Production Board.

(3) "Material" means any commodity, equipment, accessory, part, assembly or product of any kind.

(4) "Controlled material" means controlled material as defined in Schedule I of CMP Regulation 1.

(5) "Maintenance" means the upkeep of a producer's property and equipment in sound working condition.

(6) "Repair" means the restoration of a producer's property and equipment to sound working condition after wear and tear, damage, destruction of parts or the like have made such property or equipment unfit or unsafe for service.

(7) "Operating supplies" means:

(i) Material which is essential to the operation of any of the industries or services specified above and which is generally carried in a producer's inventory and charged to operating expense accounts

(ii) Material for an addition to or an expansion of property or equipment (including a minor extension of lines), provided that such addition or expansion shall not include any work order, job or project in which the cost of material shall exceed $1500 in the case of underground construction and $500

in the case of other construction, and provided that no single construction project shall be subdivided into parts in order to come below these limits.

(8) Material for "maintenance," "repair" and "operating supplies" includes only material which is essential to minimum service standards and does not include material for the improvement of a producer's property or equipment through the replacement of material which is still usable in the existing installation with material of a better kind, quality or design.

(9) "Supplier" means any person with whom a purchase order or contract has been placed for delivery of material to a producer or to another supplier.

(10) "Calendar quarterly period" means the quarterly period commencing on the first day of the first, fourth, seventh and tenth months of the calendar year and ending, respectively, on the last day of the third, sixth, ninth, and twelfth months of the calendar year, or the producer's customary accounting period closest to such period.

(11) "Inventory" means all new or salvaged material in the producer's possession, unless physically incorporated in plant, without regard to its accounting classification, excluding, however, appliances, merchandising supplies and material in the producer's possession which is segregated for use in additions and expansions specifically authorized—(a) under paragraph (e) (2) of this order, or (b) by an operative order in the P–19 series or (c) by an operative preference rating certificate issued by the War Production Board. After construction of such an addition or expansion is complete, however, any material remaining shall be included in "inventory," even though the rating therefor is still operative.

(12) "Construction" means any addition to or expansion of property or equipment having a dollar value for material in excess of the dollar values specified for "operating supplies" in paragraph (a) (7) (ii) of this order.

(13) "Class" means any one of those categories of material established as a basis for the classification of inventory in Schedule A of this order.

(14) "Short item" means any item of material which the producer estimates he will require for use in maintenance, repair or as operating supplies during the 90-day period following its delivery date.

(b) *Preference ratings:* (1) For maintenance, repair and operating supplies, a preference rating of AA–1 is hereby assigned to orders to be placed by a producer for material (including controlled material, Class A products, Class B products and other products or material).

(2) For construction of transmission, switching and distribution facilities necessary to serve rated projects or to serve rated equipment, the lowest rating assigned to such project or to the delivery of such equipment, is hereby assigned, subject to the provisions of paragraph (e) (2), to orders to be placed by a producer for material (including controlled material, Class A products, Class B products and other products or material).

(c) *Restrictions on use of rating:* The preference ratings hereby assigned shall not be applied or extended by a producer or supplier:

(1) To obtain deliveries of scarce material, the use of which could be eliminated without serious loss of efficiency by substitution of less scarce material or by change of design

(2) To obtain deliveries of material which can be purchased without the use of such ratings

(3) To obtain any item listed in Schedule E hereof.

(d) *Assignment of CMP allotment symbol:* (1) The CMP allotment symbol MRO–U is hereby assigned to orders to be placed by a producer for controlled material, *Except* aluminum, for use in maintenance, repair or as operating supplies.

(2) An order for controlled materials, *Except* aluminum, for use in maintenance, repair and as operating supplies, bearing the CMP allotment symbol MRO–U and the certification required in paragraph (e) hereof shall be deemed an authorized controlled material order and shall have the same status as an order bearing an allotment number under all applicable CMP regulations unless otherwise expressly provided. Such allotment number or symbol shall constitute an "allotment number or symbol" for the purposes of CMP Regulation 3.

(3) Aluminum required by a producer for use in construction approved under paragraph (e)(2) hereof or for use in maintenance, repair or as operating supplies may be obtained:

(i) On specific application to the War Production Board, Office of War Utilities, Washington, D.C., Ref: U–1, or

(ii) In amounts not exceeding 100 lb. per quarter as provided for in CMP Regulation 5, or

(iii) If delivery is to be from another producer, by placing an order rated in accordance with paragraphs (b) and (e) of this order.

(e) *Application and extension of ratings; application of CMP allotment symbol:* (1) *Certification:* (i) The ratings assigned by paragraph (b)(1) of this order and the CMP allotment symbol MRO–U may be applied by a producer to deliveries of material (including controlled material, Class A products, Class B products and other products or material) for use in maintenance, repair and as operating supplies, only by use of a certification in substantially the following form (in lieu of the endorsement specified in Priorities Regulation 3 and CMP Regulation 5), *Except* that no preference rating need be applied to an order to be placed with a controlled material producer.

Preference Rating AA–1, CMP Allotment Symbol MRO–U. The undersigned purchaser certifies, subject to the penalties of Section 35(A) of the United States Criminal Code, to the seller and to the War Production Board, that, to the best of his knowledge and belief, the undersigned is authorized under applicable War Production Board regulations or orders to place this delivery order, to receive the item(s) ordered for the purpose for which ordered and to use any preference rating or allotment number or symbol which the undersigned has placed on this order.

Such certification shall be signed manually or as provided in Priorities Regulation 7.

(ii) The ratings assigned by paragraph (b)(2) of this order may be applied by a producer to deliveries of material (including controlled material, Class A products, Class B products and other products or material), for use in construction to serve rated projects or equipment, by use of the certification provided in Priorities Regulation 3, as amended, *Except* that no preference rating need be applied to an order to be placed with a controlled material producer and *Provided:*

(*a*) That approval for such construction has been granted pursuant to paragraph (e)(2) hereof; and

(*b*) That the CMP allotment number assigned, upon approval of the construction pursuant to paragraph (e)(2), to deliveries of controlled

material to be used in such construction by the producer is indicated on all rated orders.

(2) In addition to the requirements of paragraph (e)(1), a producer, in order to apply the preference ratings assigned by paragraph (b)(2), or to segregate material from inventory for the uses described in such paragraph, or to accept delivery of material for such uses, must, unless otherwise directed, communicate with the Office of War Utilities, War Production Board, Washington, D.C., Ref: U–1, supplying in detail the following information or such other information as may from time to time be required:

(i) The producer's job number relating to the proposed construction

(ii) A description of the project or equipment to be served, including the location, an estimate of peak load and consumption, as well as other pertinent information

(iii) A description of the proposed utility construction, including a print of line construction showing size of conductor or pipe, capacity of transformers, pumps, compressors, tanks, holders and other equipment, the location of hydrants and important control valves, as well as other information relevant thereto

(iv) A statement of relationship to military needs, war production, public health or safety

(v) A copy of the customer's project or equipment preference rating order or certificate (Such copies of orders or certificates are not required when utilities' applications accompany the customer's project application.)

(vi) A statement explaining whether service can be rendered in any other way, or by any other producer, with the use of smaller quantities of critical materials

(vii) An estimate of the total cost of the producer's project

(viii) A list of materials required for the construction, giving the estimated weight of each material with the estimated cost, classified as indicated in the instructions for revised Form PD–200 (Such list should indicate materials in inventory not to be replaced, materials to be purchased from the excess stocks of other producers, materials to be obtained or replaced without priorities assistance and materials expected to be obtained or replaced with priorities assistance.)

(ix) The dates when deliveries of controlled material as specified on Form CMP–4C [*see* Jour. A.W.W.A., **35**: 395 (1943)] are required to meet the construction schedule and the quantities of controlled material needed during each calendar quarter, excluding, however, controlled material to be obtained from other U–1 producers.

The War Production Board will notify the producer whether and to what extent the application is approved and no producer shall apply such preference ratings, segregate material from inventory for the uses described in paragraph (b)(2) or accept delivery of material for such uses without such approval.

(3) The ratings assigned by this order may be extended by a supplier in the manner provided in Priorities Regulation No. 3 and CMP Regulation 3.

(4) An order for material, other than controlled material, bearing a rating assigned or extended in accordance with this paragraph (e) and a CMP allotment number or symbol shall have the same status as a rated order bearing a CMP allotment number under all applicable CMP regulations. Such number or symbol shall

constitute an "allotment number or symbol" for the purposes of CMP Regulation 3.

(f) *Restrictions on deliveries, inventory and withdrawal:* (1) *Scheduling deliveries:* No producer shall, in placing orders, schedule for delivery to him in any calendar quarterly period any material (whether or not rated pursuant to this order) to be used for maintenance, repair, as operating supplies or for any other purpose (except material to be segregated for use in additions and expansions specifically authorized under paragraph (e)(2) of this order, or by an operative order in the P–19 series, or by an operative preference rating certificate), the aggregate dollar value of which shall exceed one-third of the aggregate dollar value of withdrawals of material of the same class from inventory for such uses during the last nine months of 1942.

(2) *Accepting deliveries; inventory restrictions:* No producer shall at any time accept any delivery of material (whether or not rated pursuant to this order) to be used for maintenance, repair, as operating supplies or for any other purpose (except material to be segregated for use in additions and expansions specifically authorized under paragraph (e)(2) of this order, or by an operative order in the P–19 series, or by an operative preference rating certificate), if the producer's inventory of material in the same class is, or will by virtue of such acceptance become, in excess of a practical working minimum. The value of such practical working minimum inventory shall in no case exceed the aggregate dollar value of inventory permitted, class by class, by paragraph (f)(2) of Preference Rating Order P–46 as amended October 10, 1942; *Provided* that after March 31, 1943, the value of such inventory, class by class, shall not exceed:

(i) For material in the following classes—transmission and distribution, meters, house regulators and (in the case of electric power producers) wire, cable and bus bar, as well as wood poles and cross arms—four-thirds of the aggregate dollar value of items of material of the same class withdrawn from inventory for use in maintenance, repair and as operating supplies during the last nine months of 1942

(ii) For material in the following classes—source of supply, reservoirs, elevated and pressure tanks, pumping and booster stations (excluding fuel), generating station (other than fuel), production and pumping station (excluding fuel)—the aggregate dollar value of items of material of the same class in inventory on the most recent date during the calendar year 1940 on which the producer's inventory was taken, plus an amount proportinate to the increase in system output in the twelve months' period preceding the current quarter over the system output in the calendar year 1940

(iii) For material in the switching and substation class, the aggregate dollar value of items of material of the same class in inventory on the most recent date during the calendar year 1940 on which the producer's inventory was taken

(iv) For every other class of material except the classes specified in paragraphs (f)(7), two-thirds of the aggregate dollar value of material of the same class withdrawn from inventory for use in maintenance, repair and as operating supplies during the last nine months of 1942.

(3) *Withdrawals:* No producer shall, during any calendar quarterly period, make withdrawals from inven-

tory of material to be used for maintenance, repair, as operating supplies or for any other purpose (except material to be sold or to be segregated for use in additions and expansions specifically authorized under paragraph (e)(2) of this order, or by an operative order in the P–19 series, or by an operative preference rating certificate), the aggregate dollar value of which shall exceed one-third of the aggregate dollar value of withdrawals of material of the same class from inventory for such uses during the last nine months of 1942.

(4) *Exceptions:* Notwithstanding the provisions of paragraphs (f)(1) and (3):

(i) A producer may, in any calendar quarterly period, increase scheduled deliveries and withdrawals of material in any of the classes named in paragraph (f)(2)(ii), over the limits prescribed in paragraphs (f)(1) and (f)(3), respectively, proportionately to the increase in system output in the twelve months' period preceding the current quarter over the system output in the calendar year 1942.

(ii) A producer may make withdrawals from inventory of consumer's meters or house-regulators in any calendar quarterly period in an amount not in excess of one-third of the number of such meters or house-regulators condemned and destroyed by the producer in the last nine months of 1942, plus the number of meters and house-regulators necessary to serve the net increase in customers occurring in the current quarter. For the purposes of this subparagraph, withdrawals of meters and house-regulators shall not include meters or house-regulators put in service to replace meters and house-regulators removed from service.

(iii) A producer may in any calendar quarterly period schedule for delivery, or make withdrawals from inventory of, material necessary for the maintenance or repair of the producer's property or equipment which is damaged by acts of the public enemy, sabotage, explosion, fire, flood and storm or similar climatic conditions; *Provided,* that if the restrictions of paragraphs (f)(1) and (3) are exceeded because of the scheduling of such deliveries, or because of such withdrawals, a full report thereof, together with reasons therefor, shall be made immediately to the War Production Board.

(iv) A producer may in any calendar quarterly period schedule for delivery material in any class having in the aggregate a dollar value not more than the dollar value of material of the same class taken from the producer's inventory for delivery to other persons authorized to accept delivery under applicable regulations of the War Production Board, but only if, and to the extent that, such taking has reduced the producer's inventory of material of the same class below a practical working minimum; and

(v) A producer may in any calendar quarterly period withdraw from inventory material in any class having in the aggregate a dollar value not more than the dollar value of usable material of the same class salvaged from plant during the current calendar quarterly period.

(vi) A producer, in order to provide for seasonal requirements of material for the maintenance, repair and operation of his system, may in any calendar quarterly period increase the dollar value of materials withdrawn for these purposes in any calendar quarter, provided that adjustments are

made in withdrawals in other calendar quarters of the same calendar year to the extent that the total value of materials withdrawn during that calendar year do not exceed the amounts permissible to have been withdrawn during that calendar year under the terms of this order and of former Preference Rating Order P–46, as they may apply.

(5) *Short item deliveries:* Notwithstanding the provisions of paragraph (f)(2), in cases where the inventory of a class of material exceeds a practical working minimum a producer may accept deliveries of any short item within such class which is required for use in maintenance, repair or as operating supplies;

(i) *Provided,* That all material in all classes of inventory in excess of a practical working minimum is:

(*a*) Continuously recorded as excess on records kept by the producer for that purpose;

(*b*) Continuously held for sale to financially responsible persons and agencies authorized (under applicable regulations issued by the War Production Board) to accept delivery thereof; and

(*c*) Reported to the War Production Board, when requested by the War Production Board, on Form WPB–921 A, B, or C, to the extent required by such form, or in such other manner as the War Production Board may prescribe, subject to the approval of the Bureau of the Budget in accordance with the Federal Reports Act of 1942, and

(ii) Further provided that material transferred from excess to practical working minimum inventory on the records of a producer or used from excess inventory is recorded as a scheduled delivery under paragraph (f)(1); that is, that in any calendar quarterly period the aggregate dollar value of material in any class transferred on the producer's records from that portion of inventory which is separately accounted for as excess pursuant to this paragraph (f)(5) to practical working minimum inventory, or of material taken directly from such portion of inventory for use in maintenance, repair or as operating supplies, plus the aggregate dollar value of short item deliveries in such class, does not exceed one-third of the aggregate dollar value of withdrawals of material of the same class from inventory for such uses during the last nine months of 1942.

(6) The War Production Board, on its own motion or on the application of any producer, may modify the limitations on practical working minimum inventory, on scheduling or accepting deliveries or on making withdrawals set forth in this paragraph (f).

(7) The provisions of paragraphs (f)(1), (f)(2) and (f)(3) shall not apply to fuel, water purification material and gas chemical material and supplies.

(g) *Controlled material to be used in construction:* (1) Notwithstanding the provisions of any preference rating certificate or other order, except a direction referring specifically to this paragraph (g), no producer shall schedule for delivery or accept delivery of any controlled material named in, and in the form indicated in, Schedule B of this order for use in construction if his usable stocks of such controlled material are, or will by virtue of such scheduling or acceptance become, in excess of the dollar value of such controlled material he estimates will be required for use in authorized construction on

his system during the 60-day period succeeding the scheduled delivery date of such material, or the actual delivery date, whichever is the later.

(2) Notwithstanding the restrictions of paragraph (g)(1), a producer may accept deliveries of controlled material for use in construction under the circumstances stated in paragraph (c) of CMP Regulation 2.

(h) *Restrictions on additions to plant:* (1) No producer shall construct an addition to or an expansion of property or equipment and no producer shall, in the case of contract construction, accept delivery of material for such purposes, unless:

(i) Such addition or expansion is specifically authorized by the War Production Board.

(ii) Such addition or expansion is an extension less than 250 feet in length (including service drop or service pipe and any portion built by or for a consumer) of a line to serve a new building where the foundation, under the main part of the structure, was completed prior to July 1, 1942, or

(iii) Such addition or expansion requires an expenditure of material having a dollar value of less than $1500 in the case of underground construction and $500 in the case of other construction, and is not an extension of a line to consumer premises; *Provided, however,* that no single work order, job or project shall be subdivided into parts to come below these limits and that such addition or expansion requires only material which is essential to minimum service standards and does not include material for the improvement of the producer's property through the replacement of material which is still usable in the existing installation with material of a better kind, quality, or design.

(2) No producer shall connect with a line built by or for a consumer or a prospective consumer which, at the date of its completion, exceeded the restrictions of this order applicable to lines constructed by or for producers, unless the producer has been specifically authorized by the War Production Board to construct a line of substantially identical specifications to serve such consumer.

(i) *Sales from inventory:* No producer may make a sale of material from his inventory except as follows:

(1) Any sale of material which is a special sale of industrial material under Priorities Regulation 13, as amended from time to time, may be made as provided in that regulation. In addition, any producer may make a special sale of industrial material—(i) to any other producer to fill an order bearing a preference rating of AA–5 or higher or (ii) pursuant to a specific direction issued by the War Production Board, and any such sale shall be expressly permitted under paragraph (c)(3) of Priorities Regulation 13.

(2) Any sale of material which is not a special sale of industrial material under Priorities Regulation 13 may, subject to the restrictions of Limitation Orders L–31, L–94 and L–102, be made:

(i) To fill an order bearing a preference rating of AA–3 or higher, or

(ii) Pursuant to a specific direction issued by the WPB, or

(iii) To a person who produces, or to the person from whom the producer purchased, such material in the form in which it was purchased, or

(iv) To a scrap dealer as scrap, or

(v) To a used equipment dealer for resale if the item is used equipment and is not listed on Schedule D hereof, or

(vi) To the Army, Navy, Maritime Commission or a public housing authority for the repair of an actual or threatened breakdown of electric, gas, water or central steam heating facilities owned and operated by such agencies. This exception shall not be construed to extend to a sale of material for use in construction.

(j) *Placing orders:* Except in an emergency, no producer may transmit to any supplier, other than another producer, an order totaling $100 or more for the delivery of any material listed in Schedule C of this order (including material to be used in construction) without first obtaining a statement from the War Production Board Utility Inventory Control Office in his region that such material is not reasonably available in the excess inventory of another producer. This statement shall be secured by filing an inquiry, in duplicate, in letter form or by using the producer's own price inquiry forms, stating—(1) the quantity of each item required and (2) a description of the item. An oral or telephonic statement will be sufficient for the purposes of this paragraph, provided that confirmation is promptly obtained.

(k) *Refusal to sell to other producers:* Any producer may, by specific direction from the War Production Board, be prohibited from applying or extending preference ratings assigned by this order or by any other certificate or order, upon a determination by the War Production Board, that such producer has wilfully refused to sell (after receiving a bona fide offer to purchase at not less than maximum prices established by regulations of the Office of Price Administration, made by any financially responsible producer who is authorized—under applicable regulations—to accept delivery of the material specified in such offer) the following material:

(1) Material which is in inventory in excess of a practical working minimum, and

(2) Material which is included in practical working minimum inventory when such material is required by another producer for the repair of an actual breakdown of facilities or equipment.

(l) *Audits and reports:* (1) Each producer and each supplier who applies the preference ratings hereby assigned and each person who accepts a purchase order or contract for material to which a preference rating is applied, shall submit from time to time to an audit and inspection by duly authorized representatives of the War Production Board.

(2) Each producer and each such supplier shall execute and file with the War Production Board such reports and questionnaires as said Board shall from time to time request.

(3) Each producer shall maintain a continuing record of inventory and of segregated material in his possession.

(4) In addition to the records required to be kept under Priorities Regulation No. 1, the producer, and each supplier placing or receiving any purchase order or contract rated hereunder, shall retain, for a period of 2 years, for inspection by representatives of the War Production Board, endorsed copies of all such purchase orders or contracts, whether accepted or rejected, segregated from all other purchase orders or contracts or filed in such manner that they can be readily segregated for such inspection.

(m) *Communications to War Production Board:* All reports required to be filed hereunder and all communica

tions concerning this order, shall, unless otherwise directed be addressed to: Office of War Utilities, War Production Board, Washington, D.C., Ref: U–1.

(n) *Violations:* Any person who wilfully violates any provision of this order or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from process or use of, material under priority control, and may be deprived of priorities assistance.

(o) *Applicability of regulations:* This order and all transactions affected thereby, except as herein otherwise provided, are subject to all applicable regulations of the War Production Board, as amended from time to time. The restrictions of paragraph (f) of CMP Regulation 5 [*see* Jour. A.W.W.A., **35**: 386 (1943)], however, shall not apply to producers as defined in this order, nor shall the preference ratings assigned in CMP Regulation 5 supersede preference ratings assigned by this order.

(p) [Revoked April 17, 1943.]

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 527; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2(a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 17th day of April 1943.

War Production Board
By J. Joseph Whelan
Recording Secretary

Schedule A

All material in the inventory of any producer shall be carried on the producer's own records and reported to the War Production Board as may be required, classified as follows:

Water Utilities Material Classification

1. Fuel, such as coal, fuel oil, and other fuel
2. Material for source of supply, reservoirs, elevated and pressure tanks, pumping and booster stations (excluding fuels)
3. Purification materials, such as chlorine, alum, lime, other chemicals and other purification operating supplies
4. Meters
5. Transmission and distribution material and supplies (excluding meters), cast-iron, steel and wrought-iron pipe, copper and brass pipe and tubing, lead pipe, pipe fittings, valves and valve parts, hydrants, parts for meters and hydrants, other transmission and distribution materials and supplies
6. Other material and supplies.

Electric Utilities Material Classification

1. Fuel, such as coal, fuel oil, and other fuel
2. Generating station material (other than fuel), such as electrical equipment, parts and materials, chemical materials and supplies and other materials and supplies
3. Switching and substation material, such as power transformers, other station equipment, parts and material and other material and supplies
4. Wire, cable and bus bar, such as bare copper and aluminum, weatherproof copper, underground cable, aluminum and copper shapes
5. Wood poles and cross arms
6. Meters
7. Other transmission and distribution material, such as iron and steel poles, towers and parts, line hardware—overhead and underground, distribution transformers, meter and transformer parts and other line material and equipment (including insulators, lightning arrestors, etc.)
8. Other material and supplies.

Gas Utilities Material Classification

1. Fuel and gas production material, such as coal, coke, gas oil and crude oil, butane and propane, other fuel, residuals and by-products
2. Production and pumping station material (excluding fuel)
3. Chemical material and supplies
4. Meters and house-regulators
5. Transmission and distribution material (excluding meters and house-regulators), such as cast-iron, steel and wrought-iron pipe, copper and brass pipe and tubing, pipe fittings, valves and valve parts, governors and regulators, parts for meters, regulators and governors, other transmission and distribution material and supplies
6. Other material and supplies.

Schedule B

Forms of controlled material subject to the restrictions of paragraph (g):

Aluminum

Cable (electric transmission only).

Copper

Copper and copper-base alloy tubing and pipe

Copper rods and bars, including extruded shapes

Copper wire and cable (including copper content of insulated wire and cable and copper content of composite conductor).

Steel

Carbon- and alloy-steel bars, cold-finished or hot-rolled

Carbon- and alloy-steel pipe

Carbon- and alloy-steel plates

Carbon-steel rails and track accessories

Carbon-steel sheets and strip

Carbon-steel structural shapes and piling

Carbon- and alloy-steel tubing

Carbon-steel wheels and axles

Carbon- and alloy-steel wire rods, wire and wire products.

Schedule C

Items restricted by the provisions of paragraph (j):

A. *Items to be used by water utilities:*

1. Cast-iron pipe
2. Steel pipe
3. Wrought-iron pipe
4. Cement-asbestos pipe
5. Copper and brass tubing
6. Lead and lead-alloy pipe and tubing
7. Steel pipe fittings
8. Electric motors
9. Meters
10. Hydrants
11. Distribution valves, 2 inches and larger
12. Bronze valves, smaller than 2 inches, corporation cocks, curb stops
13. Pumps
14. Steel tanks
15. Steam engines
16. Chlorine control apparatus.

B. *Items to be used by gas utilities:*

1. Cast-iron pipe
2. Steel pipe
3. Wrought-iron pipe
4. Copper and brass pipe and tubing
5. Steel pipe fittings, 1¼ inches and larger
6. Mechanical pipe couplings
7. District regulators and governors
8. Gas meters
9. Valves, 1¼ inches and larger
10. Condensers (coolers)
11. Electric motors
12. Steam engines
13. Exhausters
14. Boosters
15. Compressors
16. Pumps
17. Blowers
18. Station meters.

C. *Items to be used by electric utilities:*

1. Wire (all types)
2. Cable
3. Bus-bar shapes
4. Power transformers
5. Distribution transformers
6. Watt-hour meters
7. Oil or air circuit breakers
8. Disconnecting switches

9. Electric motors
10. Current transformers
11. Potential transformers
12. Suspension insulators
13. Lightning arrestors, 20,000 volts and over
14. Steam valve, piping and fittings, larger than 3 inch and for pressures of 300 pounds and over
15. Regulators (feeder voltage)
16. Fuse cutouts
17. Automatic line splices.

Schedule D

The following items of used equipment in the possession of producers may not be the subject of a sale to any used equipment dealer pursuant to paragraph (i)(2)(v) of this order:

Used Equipment

(1) Steam generating boilers designed for pressures of 100 psi. or above
(2) Steam engines and engine generator units of more than 300 hp. rated capacity
(3) Oil or air circuit breakers of 2200 v. or higher
(4) Air circuit breakers of less than 2200 v. with interrupting capacity of 15,000 amp. or higher
(5) Metal clad switchgear of 2200 v. or higher
(6) Metal clad switchgear of less than 2200 v. containing oil or air circuit breakers listed in this Exhibit
(7) Unit substations containing transformers of 250 kva. or higher rated capacity
(8) Unit substations containing transformers of less than 250 kva. rated capacity if they also contain oil or air circuit breakers listed in this Exhibit
(9) Chlorine control apparatus
(10) Diesel and natural gas engines and engine generator units of more than 300 hp. rated capacity
(11) Liquid filled power or distribution transformers 250 kva. and larger
(12) Steam-turbine generator units of more than 300 hp. rated capacity
(13) Mechanical-drive steam turbines of more than 300 hp. rated capacity
(14) Water gas sets
(15) Gas purification apparatus
(16) Electric motors, 250 hp. or larger
(17) Pumps, 100 gpm. and larger
(18) Boosters
(19) Compressors
(20) Scrubbers
(21) Gas holders
(22) Gas station meters
(23) Blowers for manufactured gas plants
(24) Exhausters for manufactured gas plants.

Schedule E

No producer may apply the ratings assigned by this order to obtain delivery of any of the following items:

1. Fabricated containers (in knock-down or set-up forms, whether assembled or unassembled), required for packaging products to be shipped or delivered
2. Printed matter and stationery
3. Paper, paperboard and products manufactured therefrom; molded pulp products
4. Fuel or electric power
5. Office machinery or office equipment
6. Clothing, shoes or other wearing apparel, if made of leather or textiles, except that the following types may be included in operating supplies when specially designed and used to furnish protection against specific occupational hazards (other than weather):
   a. Asbestos clothing
   b. Safety clothing impregnated or coated for the purpose of making the same resistant against fire, acids, other chemicals or abrasives
   c. Safety industrial rubber gloves and hoods and linemen's rubber gloves and sleeves
   d. Gauntlet type welders' leather gloves and mittens and electricians' leather protector or cover gloves
   e. Other safety leather gloves or mittens, but only if steel stitched or steel reinforced
   f. Safety industrial leather clothing other than gloves or mittens
   g. Metal mesh gloves, aprons and sleeves
   h. Plastic and fiber safety helmets
7. Automotive replacement parts
8. Automotive maintenance equipment
9. Cellophane and similar transparent materials derived from cellulose having a gage of 0.003 in. and cellulose caps or bands of any gage.

Administrative Letter to All Utilities—March 29, 1943

UTILITIES ORDER U-1-d

SUBJECT: *Extensions of Line to Serve Buildings When the Builder Is Required to Apply for a Preference Rating or for Authority to Begin Construction.*

Attached to this letter is Supplementary Utilities Order U-1-d as amended March 29, 1943, which authorizes utilities to construct extensions of line, within stated limits of cost and weight of materials, to serve industrial, commercial or residential buildings. This supplementary order makes it unnecessary for you to file an application for permission to build extensions within these limits of the order, although, in some cases, it will be necessary to make application for an assignment of a preference rating, a CMP allotment number and a CMP allotment of controlled material.

The authority given you under this supplementary order applies to extensions to serve all types of industrial, commercial or residential buildings. In order to make use of the permission granted in the supplementary order, utilities must comply with the procedure set out herein. Two broad classes of cases must be distinguished, since a different procedure is applicable to each. One class includes all extensions to buildings for the construction or remodeling of which a preference rating or specific authorization to begin construction is being applied for by the builder. The other class includes all other cases of construction or remodeling as well as those cases where there is no construction or remodeling of the building contemplated—where only utility connections are required. This latter class is not covered by U-1-d, and, unless you can make the requested extension under some other U-1 supplement, it cannot be built except by special permission.*

To obtain preference rating assistance or authority to begin construction, all builders are required, by Limitation Order L-41 [*see* p. 660, this JOURNAL] and applicable procedures, to obtain from each utility which will serve the building either a letter stating that connections can be made under U-1 and its supplements or an application addressed to the War Production Board asking permission to make the connection. Upon request from a builder you should review his requirements for utility service and determine if connections can be made under U-1-d or any other U-1 supplement. If you can make connections within the limits of the U orders you should prepare a letter of certification to that effect.

In the case of housing construction, other than farm buildings, this certification is not to be furnished to the builder until a request for utility certifications is made by a constituent agency of the National Housing Agency. In the case of all other construction, the certification is not to be furnished until the builder's application has been reviewed by the WPB District Office (or, in the case of agri-

* Order U-1-f (in preparation and about to be released), will cover this situation.

cultural construction, by the County War Board). The NHA constituent office, the WPB District Office or the County War Board will notify the builder or the producer in writing that a letter of certification should be supplied. On presentation of this letter, if the utility extensions can be built within the limitations of U–1–d or any other U–1 supplement, you should prepare the required letter of certification, delivering it to the builder for inclusion in his application.

Before you initiate construction of such utility extensions, you should make certain that the builder has received a preference rating order of a type listed in Schedule A of Limitation Order L–41, as amended to February 19, 1943, or a specific direction from the War Production Board authorizing him to proceed with his construction. When such a preference rating order or other direction has been shown to you by the builder, you may proceed to make the utility connections, if they are permitted by a U–1 supplement.

So far as possible, you must use material from your *excess* stocks for the construction of these extensions and should not replace material so used. If necessary you may obtain material for extensions costing (for material only) less than $1500 for underground construction and $500 for other construction by applying the rating assigned in Utilities Order U–1 to deliveries of "operating supplies," and you may use the CMP allotment symbol MRO–U therein assigned. This rating and symbol may also be used to replace your stocks of material used for construction of these extensions if such use has depleted your inventory to less than a practical working minimum in the class affected.

In cases where extensions (except extensions to serve housing) exceed the cost, weight, or other limitations of Supplementary Order U–1–d, you may prepare a letter application for specific permission to build the extensions, addressed to the War Production Board, giving the information required by paragraph (e)(2) of Utilities Order U–1. In cases where extensions to serve housing are not within limits of U–1–d, you may prepare an application, using Form PD–545, asking for authority to construct. If this application involves a violation of the Housing Utility Standards, a statement explaining the points of variation should be attached. If this application is made only because extension will exceed the cost limitation of U–1–d, no explanatory statement need be attached.

Such letter applications or Forms PD–545 should be delivered to the builder for filing upon request from a constituent agency of the National Housing Agency, the War Production Board field office, or the County War Board, to supply utility applications. No such application is to be prepared by a utility until such a request has been made. You will be notified whether or not such applications for permission to build extensions have been approved, and if approved you will at that time receive an assignment of a preference rating for the construction.

If you will require controlled material to build an extension to serve any kind of construction which will cost more than $1500 in the case of underground construction or $500 in the case of all other construction you must submit a CMP–4C application [*see* Jour. A.W.W.A., **35**: 395 (1943)] di-

rectly to the Office of War Utilities, Washington, D.C. Do not file Form CMP–4C until you have been informed that the *builder's application for controlled material* to be used in his construction has been approved. You should then send Form CMP–4C directly to the Office of War Utilities, War Production Board, Washington, D.C. You will then receive a CMP allotment of controlled material.

(signed)
J. A. KRUG, *Director*
Office of War Utilities

SUPPLEMENTARY UTILITIES ORDER U–1–d AS AMENDED MARCH 29, 1943

§ 4500.5 *Supplementary Utilities Order U–1–d:* Notwithstanding the provisions of paragraph (*h*) of Utilities Order U–1, electric, gas and water facilities may be built by producers to serve premises, the construction or remodeling of which is authorized under paragraph (*b*)(4) of Limitation Order L–41 [*see* p. 660, this JOURNAL] by the issuance of a specific direction, order, certificate or other authorization for construction, provided that the following conditions are satisfied:

(*a*) *Industrial or commercial consumers:* (1) The cost of material for such utility facilities is less than $1500 in the case of underground construction, or $500 in the case of other construction

(2) Facilities can be built with an expenditure (including service drop or service pipe and any portion built by or for the consumer) of not more than 60 lb. of copper in conductor for electric service, 250 lb. for iron or steel pipe for gas service or 250 lb. of iron or steel pipe for water service (or the equivalent length of lead or lead alloy pipe or tubing), and the producer has so certified in a letter addressed to the War Production Board and attached to the builder's application for L–41 approval. Each producer must preserve on its own books a record of each work order, job or project initiated under this paragraph.

(*b*) *Domestic consumers:* (1) The cost of material for such utility facilities is less than $1500 in the case of underground construction, or $500 in the case of other construction

(2) The electric, gas or water facilities (including service drop or service pipe and any portion built by or for the consumer) can be built within the limits established by the Housing Utilities Standards, issued by the War Production Board, and the producer has so certified in a letter addressed to the War Production Board and attached to the builder's application for L–41 approval. Each producer must preserve on its own books a record of each work order, job or project initiated under this paragraph.

Issued this 29th day of March 1943.

J. A. KRUG, *Director*
Office of War Utilities

Administrative Letter to All Water Utilities—March 29, 1943

UTILITIES ORDER U–1–e

SUBJECT: *Water Connections for Gardens.*

Attached is a copy of Supplementary Utilities Order U–1–e which provides for water service for victory gardens.

No water connection may be made unless at least 5000 sq.ft. of land is to be under cultivation. Such an area of land entitles the consumer to a service extension of not more than 50 ft. Each additional 500 sq.ft. of cultivated land will be allowed an additional 5 ft. of service extension if it is requried. For example, a plot of land containing 15,000 sq.ft. of land devoted to the production of edible crops would be entitled to a maximum length of service extension of 150 ft. The limit on the length of service extension is 250 ft. for any one plot of ground. This does not preclude several extensions being made to the same plot of ground, provided that the combined length of all extensions does not exceed the allowable length for a single service. Premises already served with water from the producer's system or from any other source will not be entitled to receive an extension under the conditions of Order U–1–e.

Lead or lead alloy pipe, cast-iron pipe or steel pipe may be used in making permissible connections so long as the size limitation of the order is observed.

Material for these connections should be taken from each producer's excess inventory to the extent that it is available therein. If material is not available in a producer's excess inventory, an attempt should be made to purchase it from other water producers. If this, after a reasonable effort, cannot be done, material may be purchased. Material purchased must be included in the producers' quotas of materials scheduled for delivery. All material used must be accounted for in records of withdrawals.

Your attention is directed to paragraph (g) of Supplementary Utilities Order U–1–e which requires that a consumer agree with the producer in writing that he will use the water service, subject to rules promulgated in the interest of water conservation. It is essential that consumers of water utilities which anticipate even a minimum shortage of water or of pumping capacity during the growing season be notified that conditions may arise which will necessitate curtailment of the use of water for crops, and that such curtailment may take the form of specified hours or days of use, or, in the case of a severe water shortage, complete interruption of service.

(signed)
J. A. KRUG, *Director*
Office of War Utilities

SUPPLEMENTARY UTILITIES ORDER U–1–e— VICTORY GARDENS

§ 4500.6. *Supplementary Utilities Order U–1–e:* Notwithstanding the provisions of paragraph (*h*) of Utilities Order U–1, water service extensions of not more than 250 ft. (including any portion built by or for the consumer) may be made or connected by producers to provide water for gardens: *Provided,* That all of the following conditions are satisfied:

(*a*) There is no alternative source of water which would require less critical material.

(*b*) Water from each such extension will be used to provide water for not less than 5000 sq.ft. of land devoted to the production of edible crops.

(*c*) Extensions are made with not more than 5 ft. of pipe for each 500 sq.ft. of cultivated land.

(*d*) Pipe of the smallest practicable size, and in no event having a nominal inside diameter greater than $1\frac{1}{4}$ in., is used.

(*e*) No copper or copper base alloy pipe or tubing is used.

(*f*) No extension or enlargement of mains is required.

(*g*) The consumer agrees in writing with the producer that his use of water for the purposes of this supplementary order will be subject to rules promulgated by the producer in the interest of water conservation, including requirements for off-peak usage and interruption of service during periods of water shortage.

Issued this 31st day of March 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN
Recording Secretary